SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH 1906.

GENERAL PHYSICS.

469. *Improved Chronograph.* **R. L. Mond** and **M. Wildermann.** (Zeitschr. Phys. Chem. 54. pp. 294–304, Jan. 23, 1906. Phil. Mag. 11. pp. 393–402, March, 1906.)—In the ordinary rotating drum chronograph the inertia of the moving parts is so great in comparison with the driving power of the clock that irregularity of motion results. The authors have designed an instrument in which this difficulty is overcome by keeping the drum fixed and causing the marker to rotate around it; also the same marker is used to indicate both the calibrating time signals and the signals to be recorded, marks of different lengths being used for the two purposes. The construction is given in great detail, both horizontal and vertical patterns being described. The cylinder is 60 cm. in circumference, and the marker can be made to rotate in 10 sec. or 1 min., 50 turns in all being possible. Owing to the regularity of the motion the time may be recorded to within 1/300 or 1/50 sec. respectively. S. G. S.

470. *Machine for Bending Tests.* **E. Probst.** (Eng. Record, 53. pp. 52–53, Jan. 13, 1906. Eng. Rev. 14. pp. 213–214, March, 1906.)—Describes, with illustrations, a machine at the Institution for Testing Materials, Zürich, for testing beams up to nearly 4·3 m. long, the load up to a maximum of 126 tons being applied by means of seven simultaneously actuated hydraulic jacks, using oil. Each of these rests on a steel sphere, and the tops of the pistons act upon the beam through tipping pieces. It is possible to place the central plane of the beam to be tested with great accuracy in the plane of the forces. Apparatus is provided for observing deflection, and hence stiffness, but breaking is not generally attempted. Tests on reinforced concrete are in progress. F. R.

471. *Large Testing Machine.* (Mech. Eng. 17. pp. 191–192, Feb. 10, 1906. Engineering, 81. pp. 206 and 208–209, Feb. 16, 1906.)—Describes with illustrations a 600,000-lb. machine of similar type to Riehlé's "U.S. standard vertical screw-power" testing machine, built for the University of Illinois. A weighing table is supported on 8 knife-edges on the main levers, and carries, on cast-iron columns, the weighing head. The pulling head, driven by two main screws, moves up and down between guides, which are a new feature in this type of machine. The screws are actuated by a 15-h.p. motor through clutches and gear controlling the rate of movement of the head from 0·05 to 8 in. per min. Compound levers are used, and an additional needle lever adds to the sensitiveness of readings. The shock on the knife-edges is minimised by dissipating the energy of recoil in forcing water through a small aperture. The extreme height of machine is 36 ft. 8 in., and it takes compression specimens up to 25 ft. long, tensile up to 22 ft., and transverse up to 10 ft. F. R.

472. *Coloured Markings in Test-piece Fractures.* **H. G. Howorth.** (Iron and Steel Inst., Journ. 68. pp. 301–314; Discussion and Correspondence, pp. 315–319, 1905. Engineering, 80. pp. 464–465, Oct. 6, 1905.)—Coloured streaks and patches have been observed on the fractures of test-pieces cut from forgings of gun-steel; these are sometimes visible to the unaided eye, but a magnification of 15 diams. is often required. The colour is only visible under strong oblique illumination, preferably in direct sunlight. The fractures in which these markings are observed are not good, lamination being common, and elongation at fracture being reduced. The markings most frequently occur at the bottom of ingots, and are most frequent and largest at the breech-ends of gun forgings. The author identifies the markings with flaws commonly present in the steel, and believes that similar markings are always present. Chemical examination proves the flaws to contain manganese sulphide embedded in manganese silicate. The author considers that in the breech-ends of guns these flaws would prove starting-points for erosion, while under alternating stresses they might develop into cracks. W. Ros.

473. *Shear Stress and Permanent Angular Strain.* **W. C. Popplewell.** (Engineer, 101. pp. 53–55, Jan. 19, 1906.)—Gives in detail results announced briefly by the author and E. G. Coker (Inst. Civ. Engin., Proc. 122. 1895), obtained in torsion tests to destruction of solid and hollow wrought-iron and mild steel bars. The straining occurs in three well-marked stages: (1) Elastic; (2) partly elastic and partly plastic; (3) mainly plastic. The angle between a generator of the surface of bar, and the position which that line takes upon twisting is here called the "angle of distortion" (α). Upon plotting log α against the log of twisting moment (T) two straight lines of slightly different inclinations are obtained for the two final stages of deformation. Laws of the form $T = A\alpha^n$ hold, A and α differing for the two stages, for solid and hollow pieces, and for steel and iron. [See also Abstract No. 1335 (1905).] The results are applied to the case of the action of a cutting tool (Mallock's theory). (Ibid. p. 148, Feb. 9.) **R. H. Smith** points out that in the tables given m and n have been interchanged by error; also that $m/n = (B/A)^{\frac{m+n-2}{m-1}}$ otherwise a sudden break would occur in the curves. F. R.

474. *Impact Testing.* **H. R. Sankey.** (Engineer, 101. pp. 84–86, Jan. 26, 1906.)—States conclusions from experience with the machine referred to in Abstract No. 2254B (1904). The actual thickness of the specimen, except at the bottom of notch, is found to be unimportant. With any given mode of notching (file, saw, cold chisel) uniform results can be obtained; and, within limits, the actual initial energy in the tup does not affect the consistency of the indicated energy absorbed by the test-piece. The relative advantages of the one-blow and many-blow methods of impact testing are discussed. [See also Abstracts Nos. 2217B (1904) and 404B and 1640B (1905).] (Ibid. p. 121, Feb. 2.) "T." mentions the desirability of tensile impact tests. [See, however, Abstracts Nos. 2797B (1904), 928 and 928B (1905).] F. R.

475. *Tensile and other Tests.* **A. Campion.** (Mech. Eng. 17. pp. 144–146, Feb. 3, 1906. From West of Scotland Iron and Steel Inst., Journ.)—The results of drop tests on 6-in. bars, and of tensile tests, of a 0·35 per cent. carbon steel are given. It is endeavoured to trace the relation, if any, between the impact result and the ratio of, or difference between, elastic limit and maximum stress. It is found that there is agreement only with more than 0·25 per cent. carbon. The percentage contraction at fracture is erratic, and does not appear to be related to the shock-resisting power. Some incomplete alternating stress tests gave results at variance with generally accepted ideas. All the steels were tested as rolled, forged, annealed, or soaked. F. R.

476. *Photographic Measurement of Sea-waves.* **W. Laas.** (Zeitschr. Vereines Deutsch. Ing. 49. pp. 1889–1895, Nov. 25; 1937–1942, Dec. 2; and pp. 1976–1981, Dec. 9, 1905.)—During a voyage of the five-masted sailing-ship *Preussen* from Hamburg to Chili and back wave photographs were taken on the stereometric principle, and from these diagrams or maps of the waves were afterwards made both by drawing and by means of a Pulfrich-Zeiss stereocomparator. Three special cameras were employed, taking isolar plates 18 × 18 cm.; these had six fixed stands, three on each side of the ship, viz., two on the poop deck and four on the bridge deck, and, the shutters being controlled electromagnetically, simultaneous photos could be taken when desired from two positions on the same side of the ship. The paper deals very fully with the measuring and mapping process, and is illustrated by many photographs and diagrams and a wave map. A shutter speed of 1/100 sec. was found to be barely fast enough to avoid displacement in the photos, the velocity of sea-waves being in general from 10 to 15 m. per sec. G. E. A.

477. *Surface Tension at the Interface between Liquids and Vapours.* **A. L. Clark.** (Amer. Acad., Proc. 41. No. 16. pp. 361–381, Jan., 1906.)—The capillary-tube method is employed, the angle of contact being determined from the radius of the tube and the height of the meniscus, assuming the latter to be spherical. The three pairs of substances experimented upon are ethyl alcohol vapour and olive oil, ethyl ether vapour and glycerine, and liquid ether and glycerine, the temperature varying from 12° to 240° C., and the pressure from 1 to 60 atmos. A special thermostat is built for the purpose, the heating being electrical; the manometer is of the mercury type, reducing cylinders as used by Amagat being employed. A difficulty was experienced in the case of ether vapour and glycerine, owing to the fact that the ether condensed upon the surface of the glycerine, even when the temperature is slightly above the critical temperature. This difficulty was got over by supplying an extra amount of heat by means of an auxiliary coil, the current in the coil being passed for a known time. This heat was just sufficient to evaporate the ether, and the resulting temperature was found by a later experiment using a thermo-couple. The results are exhibited in the form of curves and are in agreement with those of Ramsay and Shields (Phil. Trans. 184. p. 647, 1893), which shows "that the surface tension of a liquid in contact with its own vapour obeys approximately the same laws as for a liquid in contact with the vapour of another liquid." S. G. S.

478. *Surface Elasticity of Saponine Solutions.* **S. A. Shorter.** (Phil. Mag. 11. pp. 317–328, Feb., 1906.)—The mechanical properties of the surface layer are examined by means of a disc and torsion balance. When the disc is displaced through an angle and let go, the motion may be (1) a drift back to the zero position; (2) a damped oscillation about the zero position; or (3) a combination of the two motions of drift and damped oscillations. The theory of these motions is given, and from the observations absolute values of the surface rigidity are deduced, ranging from 88 to 65 dynes per cm. E. H. B.

479. *Seismographs.* **A. v. Büky.** (Phys. Zeitschr. 7. pp. 122–130, Feb. 15, 1906.)—Moved by the very different registrations of the same earth-tremor shown by different seismographs at the same place the author works out the theory of the Wiechert seismograph, and concludes that (1) if the period of the tremor is much longer than that of the pendulum, the free end of the latter and its support move practically alike, so that the instrument does not register the tremor; (2) if the pendulum's period is much the longer, its free end practically does not move and the registration is practically true; if, for instance, the pendulum's period is 10 times that of the tremor the amplitude of swing of its lower end is only one-hundredth of that of the tremor, so that the registration is only 1 per cent. in error. R. E. B.

480. *Vibrations produced by Collisions.* **Rayleigh.** (Phil. Mag. 11. pp. 283–291, Feb., 1906.)—The problem of the collision of elastic solid bodies has been treated theoretically in two distinct cases. The first is that of the longitudinal impact of elongated bars, which for simplicity may be supposed to be of the same material and thickness. Saint-Vénant showed that, except when the lengths are equal, a considerable fraction of the original energy takes the form of vibrations in the larger bar, so that the translational velocities after impact are less than those calculated by Newton for bodies which he called perfectly elastic. It will be understood that in Saint-Vénant's theory the *material* is regarded as perfectly elastic, and that the total mechanical energy is conserved. The duration of the impact is equal to the period of the slowest vibration of the longer bar. The experiments of Voigt, undertaken to test this theory, have led to the conclusion that it is inapplicable when the bars differ markedly in length. The observations agree much more nearly with the Newtonian law, in which all the energy remains translational. Further, Hamburger found that the duration of impact was much greater than according to theory, though it diminished somewhat as the relative velocity increased. These discrepancies need not cause surprise when it is noted that the theory presupposes a condition of affairs impossible to realise in practice. Thus it is assumed that the pressure during collision is uniform over the whole of the contiguous faces. But, however accurately the faces may be prepared, the pressure, at any rate in its earlier and later stages, must certainly be local and be connected with the approach by a law altogether different from that assumed in the calculation. This leads the author on to the second case, namely, Hertz's solution, under certain conditions, of the problem of impinging curved bodies. Hertz first treats the case of static contact under pressure, and then passes to its application to impacts. It thus appears that the time of contact of impinging bodies, though very small in absolute value, is yet very large compared with the time taken by waves of elastic deformation in the bodies in question to traverse distances of the order of magnitude of that part of their surfaces

which is common to the two bodies when in closest contact. The author then applies Hertz's results to the problem of the impact of two spheres, this case having special interest in connection with the kinetic theory of gases. The analysis, involving zonal harmonics, is too complicated for introduction here, but the general conclusion shows (1) that Hertz's theory of collisions has a wider application than might have been supposed; (2) that under ordinary conditions vibrations should not be generated in any appreciable degree; (3) that, so far as this conclusion holds, the energy of colliding spheres remains translational; (4) the velocities after impact being ascertainable by Newton's laws from the principles of energy and momentum.

E. H. B.

481. *Mohn's Results of Nansen's North Polar Work.* (Monthly Weather Rev. 33. pp. 401–402, Sept., 1905.)—The results of the Norwegian North Polar Expedition of 1893–1896 are being published in quarto volumes. The meteorological sections have been prepared by H. Mohn; most of the observations were made by S. Scott-Hansen, H. Johansen, and B. Nordahl. The data are particularly valuable, because the *Fram* drifted with the ice for 3 years, always at considerable distance from any continents or islands. The 3 years comprise 3 winter nights, each of 4 months, and 3 summer days, each of 4½ months. The ship passed through 73 areas of low pressure, in ten cases through the centre of the depression; the wind velocities were not great on these occasions—not more than 40 miles per hour—and not great on the whole; the barometer extremes observed were 771·7 and 724·1 mm. During the long nights the sun-rays would warm incipient precipitations in the higher strata, and, keeping the sky serene, favour radiation; the local temperature therefore fell when the sun was near the meridian. The heating power of the twilight (the heat-twilight of Dove) was noticed.

H. B.

482. *Change of the Geyser of Atami.* **K. Honda** and **T. Terada.** Physico-Mathematical Soc., Tokyo, Proc. 2. 28. pp. 433–442, 1905.)—The activity of the Atami geyser [see Abstract No. 331 (1905)] decreased extraordinarily in May, 1905, and long-continued boiling (nagawaki) was twice observed. The inverted daily barometer curve and the curve marking the time of eruption are strikingly parallel. The temperature in the orifice at a depth of 1·5 m. is 103 or 104° C. The boring of more wells—there are now twenty in the district—has diminished the activity of the geyser; the temperature of the water in one of these wells is 62° C. at the surface, 95·5° at a depth of 23 m., and 118·2° at a depth of 31 m. The level of a well near the geyser fluctuates distinctly with the activity of the geyser, and tidal and barometer influences can also be recognised; in a well further off, the level rises and falls with the tide. The phenomena of the eruptions and the "nagawaki" can be imitated with the aid of a model, comprising a feed-tank, a side tank, and a smaller cavity which is heated by a burner, all interconnected by pipes.

H. B.

483. *Existence of Secondary Vibrations in Seismic Waves.* **H. Nagaoka.** (Physico-Mathematical Soc., Tokyo, Proc. 2. 28. pp. 443–446, 1905.)—The imperfect elasticity of rocks, studied by Kusakabe, causes deviations from Hooke's law and affords a clue for investigating the free and forced vibrations to which the earth is subjected during earthquakes. The author [see also Abstract No. 1547 (1905)] shows for two earthquakes that the principal vibration is partly free and partly forced, and that the end portion of the vibration is entirely forced. This would also apply to eleven other distant earthquakes. In earthquakes of near origin the octaves are often to be traced, but the analysis is difficult. Discussions of surface seismic waves have little or no value in his opinion. H. B.

484. *Effect of Lunar Deflection of Vertical on Latitude Determination.* **B. Cookson.** (Cambridge Phil. Soc., Proc. 13. pp. 198–200, Jan. 31, 1906.) —The maximum tide-raising force of the moon on a point of the earth's surface amounts to 1/8,500,000 of gravity at the point, and the maximum horizontal component of this force may be nearly 1/12,000,000. Thus, owing to this force, the plumb-line may be deviated through an angle of $\frac{1}{12}.10^{-6} \times \operatorname{cosec} 1''$, that is $0{\cdot}017''$ or about $0{\cdot}02''$. As the latitude by the zenith sector is generally determined from the meridional zenith-distances of stars, we require only the southward component of the moon's tide-raising force. It is found, however, that the probable error is more than the above amount, so the problem is to determine the amplitude of an oscillation of known period from observations of which the probable error is about three times the quantity sought. Besides the moon's tide-raising force, there is also the sun's, which is nearly half that of the moon, and the effect of the two are superposed. When Küstner's method is used, the observations are made symmetrical about midnight, and the solar terms can be made to disappear from the formula of latitude variation. To test the possibility of this variation being measurable, the latitude determinations by Doolittle made at Philadelphia between 1898 (Sept. 16) and 1901 (Aug. 30) have been examined. There appears to be an oscillation with a period of half a lunar day and an amplitude of $0{\cdot}025''$, the maximum value occurring 6h. after the transit of the moon. C. P. B.

485. *Anomalous Tails of Comets.* **E. E. Barnard.** (Astrophys. Journ. 22. pp. 249–255, Nov., 1905.)—The author describes various novel facts concerning the formation and appearance of the tails of comets, the discussion of which leads him to think that the views generally accepted may have to be considerably modified in future. No explanation has been definitely found to account for all the many details exhibited by the growth and dissipation of a comet's tail, but that of Bredechin has probably received most favour up to the present time. In this, as in most other theories, it has been customary to ascribe practically all the cause of the phenomena to the action of the sun, supposing the comet to merely supply the material to be acted upon. During the last 10 or 12 years much new evidence has been adduced, chiefly owing to the application of photography, and the author, after a close consideration of this, thinks that three causes are at work. First, the sun, producing a disturbing action in the nucleus of the comet, and determining the general direction of the tail-producing particles. Second, the cometary matter itself, in which a strong ejective power appears to be located, this being proved by the frequent formation of straight minor tails or streams of particles which often issue at large angles to the general direction of the main tail. Such peculiarities are quite different from the effects produced by the sun. Third, an outside influence quite apart from the comet, indicated by the many rapid distortions and deflections so often seen. There appears to be evidence that this is due to some kind of resistance of a medium not uniformly distributed in interplanetary space. Instances of these effects are illustrated by the photographs of Brooks'

Comet taken in Oct. and Nov., 1893. The author suggests that these changes give reason for more attention being devoted to comet photography. He concludes that it appears more likely that the different components of the tails of a comet are all made up of the same kind of particles, and what spectroscopic evidence is as yet available is not opposed to this view.

C. P. B.

486. *Duration of Totality of Solar Eclipse, Aug.* 30, 1905. **J. Y. Buchanan.** (Nature, 73. pp. 173–174, Dec. 21, 1905.)—Observing from Torreblanca, about a mile to the south-west of the central line of eclipse, it was found that the brilliant display of prominences seen at second contact were quite covered over by mid-totality. With the sun's altitude about 54·5°, the augmentation of the moon's semidiam. is 14·3″. Adding this to the geocentric semidiam., 16′ 21·4″, the value 16′ 35·7″ is obtained for the apparent semidiam. of the moon as seen from Torreblanca at mid-totality. Deducting from this the semidiam. of the sun, viz., 15′ 50·7″, we obtain 45″ as the width of the annular band by which the disc of the moon overlapped that of the sun. This means that no protuberance of less than 45″ high would be visible at mid-totality. Eight seconds before second contact the author detected the streamers of the outer corona on the western limb of the moon, but there was no trace of the more brilliant inner corona. On the argument from parallax, therefore, at this time, the light-giving portion of the inner corona could not extend more than 93″ or 94″ from the sun's limb. This strong light during eclipse is said to be in contrast to that observed in 1882, when the darkness during totality was very marked, and as it is computed that the difference of the moon's and sun's diams. was then only 15·4″, it is evident that the activity was much greater in 1905 than in 1882. C. P. B.

487. *Solar Eclipse Observations, Aug.* 30, 1905. **A. A. Nijland** and **W. H. Julius.** (Konink. Akad. Wetensch. Amsterdam, Versl. 14. pp. 463–472, Dec. 6, 1905. Proc. 8. pp. 501–510, Dec. 21, 1905.)—*Dutch observations near Burgos.* Very unfavourable weather was experienced, and the spectroscopic work was without result. For the heat radiation a direct-receiving thermopile was employed. About 80 observations were taken, and many of the values lost on account of the interposition of clouds could be interpolated after the curve of variation had been plotted. The deflection produced by full sunshine was equal to 200,000 times the minimum deflection during the totality, so that this latter would be about equal to two-fifths that of the full moon. *At Aosta, Italy.* **F. Jehl.** (Comptes Rendus, 141. pp. 648–650, Oct. 23, 1905.)—The eclipse here was partial only. *At Almazan, Spain.* **J. A. Miller.** (Astrophys. Journ. 23. pp. 93–95, Jan., 1906.)—The results obtained by the Kirkwood Observatory, Indiana University, under somewhat unfavourable weather conditions, are described. *At Tortosa, Spain.* **T. Wulf** and **J. D. Lucas.** (Phys. Zeitschr. 6. pp. 838–847, Dec. 1, 1905.)—Observations were made with a selenium cell detector in circuit with a galvanometer.

C. P. B.

488. *Observations during Total Solar Eclipse, Aug.* 30, 1905. (1) *At Castellón de la Plana, Spain.* **H. L. Callendar** and **A. Fowler.** (Roy. Soc., Proc. Ser. A. 77. pp. 1–28, Jan. 3, 1906.)—Extensive preparations were made for many branches of observation, but the region of the eclipsed sun was, however, entirely covered by thick clouds throughout totality. (2) *At Sfax, Tunisia.* **W. Christie.** (Ibid. pp. 28–41.)—Observations were made

in good weather, valuable results being obtained with all instruments. (1) Photographs of the corona and prominences were obtained with the Thomson coronagraph and the Astrographic telescope. (2) Photographs of the spectrum of the corona and prominences with two spectrographs, one having a quartz optical train for recording the ultra-violet radiations. Several new lines were found on the plates of the corona spectrum. (3) *At Pineda de la Sierra, Spain.* **J. Evershed.** (Ibid. pp. 42–55.)—Very complete arrangements were made, but bad weather quite spoilt all the observations. (4) *At Guelma, Algeria.* **H. F. Newall.** (Ibid. pp. 56–76.)—Excellent observations were secured with various instruments. (*a*) A sheaf of 7 photographic cameras, fed from a 16-in. coelostat mirror, for recording the extensions, brightness, and spectrum of the coronal radiation, photographs of the corona in polarised light at various angles; (*b*) photographs of the chromospheric spectrum with an objective grating spectrograph. [For polarisation phenomena, see next Abstract.] (5) *At Aswan, Egypt.* **H. H. Turner.** (Ibid. pp. 77–96.)—Good observations were made on the determination of the brightness of the corona by photographic methods at different distances from the moon's limb; on the fraction of the coronal light which was radially polarised. (6) *At Kalaa-es-Senam, Tunis.* **L. Becker.** (Ibid. pp. 97–99.)—Successful photographs were obtained with two cameras of 60 and 12 in. focus respectively, showing the variation in extent of the coronal radiation with distance from the sun's limb. C. P. B.

489. *Polarisation Phenomena during Total Solar Eclipse.* **H. F. Newall.** (Cambridge Phil. Soc., Proc. 13. p. 197, Jan. 31, 1906.)—Records of the extent of polarisation in the various regions of the solar corona were obtained photographically during the total solar eclipse on Aug. 30, 1905, at Guelma, Algeria. It was found that the combined result of the visual and photographic records indicated that the plane of polarisation of the light diffused by the earth's atmosphere during the eclipse was very nearly horizontal. This view conflicts with that of Salet [see Abstract No. 31 (1906)], who found this plane to be vertical. Photographs taken with a Savart camera for quantitative measurements showed that the polarised portion of the atmospheric light was equal in intensity to the radially polarised portion of the coronal light at a distance of about 1½ diams. from the sun's limb. The results obtained by photographing the corona through a large nicol prism, which was set to transmit successively the vertical component and two components which were inclined on each side at 45° to the vertical and consequently perpendicular to one another, not only show the strong radial character of the polarisation of the corona, but also seem to suggest that there is a selective action, and that the prominent streamers of the corona are markedly polarised. A photograph taken with a new form of polarising spectrograph shows a very marked difference in the intensities of the tangential and radial components; a curious feature in this connection is that the Fraunhofer lines are not detected in either spectrum, though the conditions are such as must be regarded as very favourable for their detection. C. P. B.

490. *Photographic Observations of Sun-spot Spectra with the "Snow" Telescope.* **G. E. Hale** and **W. S. Adams.** (Astrophys. Journ. 23. pp. 11–44, Jan., 1906. Contribution from the Solar Observatory, No. 5.)—Using the Snow telescope (described by Hale, Ibid. pp. 6–10), having a concave mirror of 24 in. aperture and 60 ft. focus, and giving a solar image of 6·7 in. diam., the spectra were obtained by means of a Littrow spectrograph of 4 in. aperture and 18 ft. focus, in conjunction with a 4-in. plane Rowland grating with 14,438 lines to the inch, using the second order spectrum. Tables are given of the lines found affected in the spot spectra, with their origins and intensities compared with the intensity of neighbouring Fraunhofer lines. The linear scale of the plates is very nearly 1·5 tenth m. = 1 mm. In the table 345 lines are indexed, 267 of which are common to the list of 352 lines given by Mitchell [Abstract No. 2027 (1905)]. A summary of the lines affected indicates that the lines of titanium are not changed, followed by those of Mn, Cr, Ni, Fe, and Co. The authors confirm Mitchell's conclusion that lines due to water vapour are not affected in the spot spectrum. Special attention is drawn to the peculiar fact that *all* the silicon lines in the region examined, 7 in number, are much *weakened*, this point being of importance in connection with the occurrence of members of the carbon group in the sun. Careful measurements of the photograph result in the conclusion that the fine lines into which the *spot bands* are seen to be resolved can be identified with faint lines in the Fraunhoferic spectrum, thus indicating that the absorbing vapours which cause the local darkness of a sun-spot are also thinly spread over the whole solar disc. C. P. B.

491. *Stellar Magnitude of the Sun.* **W. Ceraski.** (Astronom. Nachr., 170. pp. 135–138, 1906. Nature, 73. p. 279, Jan. 18, 1906. Abstract.)—A research undertaken in the attempt to connect up the brightness of the Sun and stars by definite comparisons. During the daytime the light from a reflected image of the Sun was photometrically compared with the light received from Venus. At night the planet Venus was then compared with the stars Polaris, Procyon, and Sirius. Taking the magnitudes of these as being 2·15, 0·56, and —1·09 respectively, the author obtained the values —26·51, —26·66, and —26·67 as the stellar magnitude of the Sun, from which he deduces the most probable mean value as equal to —26·59. C. P. B.

492. *Probable Volcanic Action of Nebulous Matter.* **J. M. Schaeberle.** (Nature, 73. pp. 296–297, Jan. 25, 1906.)—The author has previously suggested that streams of finely-divided matter may be ejected from the sun, each stream necessarily taking the form of a helix, and stated that the nebulosities surrounding certain stars were probably caused by the presence of streams similar to those which produce the solar corona. In a later effort to explain the fact that in certain spiral nebulæ two diametrically opposite streams are, as a rule, most conspicuous, Chamberlin advanced the theory that the disruption of one body through tidal action and centrifugal force caused by the near passage of another body moving with great velocity would account for the phenomenon [see Abstract No. 25 (1906)]. The author does not think such external forces necessary for the explanation, and suggests that as the result of decrease in temperature from the centre to the surface of an incandescent mass exposed to the cold of space, the surface crust finally formed will be punctured at various points by the imprisoned gases, thus also allowing the more refractory matter from the interior to overflow the region immediately surrounding each vent; the increased weight of the locally thickened crust causes the lower opening to be depressed below the general level; as the height of the surface cone increases, the simultaneously formed inverted cone is forced deeper and deeper into the regions of greater temperature and pressure, where matter exists in the form of compressed gases. The more easily volatilised materials of the depressed mass will be dissipated, leaving only the more refractory elements to form the inverted cone. The theoretical conclusion would thus be that in the act of cooling an originally incandescent body has the power to create conditions which will enable it to remove a part of its mass, in a finely-divided state, to distances which may be far beyond the sphere of its own sensible attraction. C. P. B.

493. *First Photographs of the Canals of Mars.* **P. Lowell.** (Roy. Soc., Proc. Ser. A. 77. pp. 132–135, Feb. 8, 1906.)—After many attempts the author has succeeded in obtaining very beautiful photographs of the planet Mars, showing most distinctly the canals which have given so much occasion for controversy. They were secured with the 24-in. refractor at the Flagstaff Observatory, Arizona, and are much superior to those obtained last year [see Abstract No. 1362 (1905)]. The improvement has been made possible by a very close study of the necessary atmospheric conditions for perfect definition. It has been found that much depends on the wave-length of the air disturbance compared with the diam. of the objective; if this length is double the diam. of the glass there will be a bodily oscillation of the whole image in the field of view; but if the wave-length is shorter than this, partitive motion occurs, while the bodily motion is reduced, and though we may get a steady image, a blurring and finally a complete obliteration of the delicate detail ensues. In many cases quite surprising improvement was secured by diaphragming down the objective to the proper degree suitable for the particular wave currents travelling at the moment. Another important feature which is thought to have greatly conduced to success was the introduction of a colour screen specially suited to the colour-curve of the objective. For the photographs Cramer isochromatic plates were employed, and the camera was so arranged with a repeating back that numerous pictures of the planet could be obtained on the same plate, so as to increase the chances of catching the intermittent periods of best definition. In this way some 700 images of the planet were photographed during the time that it was favourably placed for observation at the last opposition. The time available was only while the planet subtended an arc of about 15 seconds, and most of the plates show the canals. The photographs show that, within the limits imposed by the silver grains of the plates, the canals are lines, narrow and direct, following either arcs of great circles or curving (like the Djihoun) in a systematic manner, thus proving, to the extent of their ability, the conclusions previously reached at Flagstaff from eye observations. The author does not wish to assert positively at present, but he thinks he has evidence that both a double canal and a double oasis have been photographed. In the reproductions given in the paper there are drawings shown which were made at the same time but quite independently, and there is a very marked agreement in most of the features. C. P. B.

REFERENCES.

494. *The Equal-arm Balance.* **H. V. Carpenter** and **Z. E. Bisbee.** (Phys. Rev. 22. pp. 31–44, Jan., 1906.)—The equation of static equilibrium is worked out and brought to simpler forms according as no bending of the beam is assumed and the knife-edges are taken to be in the same plane. The equations are then verified by experiments on short-beam and long-beam balances. G. E. A.

495. *Integration of Maxwell's Equations.* **F. Hasenöhrl.** (Deutsch. Phys. Gesell., Verh. 7. 24. pp. 450–457, Dec. 30, 1905. Phys. Zeitschr. 7. pp. 37–40, Jan. 15, 1906. Paper read before the 77 Naturforscherversamml. at Meran, Sept. 26, 1905.)

496. *Parhydric Valve.* **J. de Rohan Chabot.** (Comptes Rendus, 142. pp. 153–154, Jan. 15, 1906.)—To prevent the possible suction of water into a vessel from which air is being removed by a water-pump, the author uses what he calls a *parhydric* valve, which consists of a float with its top slightly concave and covered with a membrane. If the water rises this is pressed against the flat-ground bottom of the tube connecting with the vessel and prevents flow of water into it. R. E. B.

497. *Expeditious Practical Method of Harmonic Analysis.* **T. R. Lyle.** (Phil. Mag. 11. pp. 25–41, Jan., 1906.)—The method is that referred to in Abstract No. 75B (1904), in which the author's wave-tracer and analyser is described. Illustrations for triangle, trapezium and polygon as wave-forms are given. J. W. P.

498. *Deep Sea Ship-waves.* **Kelvin.** (Roy. Soc. Edinburgh, Proc. 25. pp. 1060–1084 (1904–1905). Phil. Mag. 11. pp. 1–25, Jan., 1906.)—A continuation of the mathematical treatment of Abstract 1180 (1905), in which the effect of a specified forcive set in motion is analysed. J. W. P.

499. *Equilibrium of an Elastic Body for given displacements of the Points of its Surface.* **A. Korn.** (Comptes Rendus, 142. pp. 334–336, Feb. 5, 1906.)—By writing the usual equations of equilibrium in the form—

$$\nabla^2 u + (2\partial\theta/\partial x - \nabla^2 u)k/(2+k) = 2X/(2+k), \text{ \&c.},$$

the author obtains a solution of the problem, by Lauricella's method of successive approximations, in terms of series which are convergent, not only at a finite distance from the surface as in E. and F. Cosserat's solution, but also at points indefinitely near the surface. R. E. B.

500. *Temperature-distribution in Explosive Quasi-waves.* **P. Duhem.** (Comptes Rendus, 142. pp. 324–327, Feb. 5, 1906.)—The author concludes that within a very viscous liquid quasi-waves of explosion cannot be formed whose thickness is very small in comparison with the coefficients of viscosity, but that such a wave might be formed of thickness comparable with these coefficients, and that in this case the temperature could have only slight variation from one side of the wave to the other. R. E. B.

501. *National Bureau of Standards.* **S. W. Stratton** and **E. B. Rosa.** (Amer. Inst. Elect. Engin., Proc. 24. pp. 1039–1090, Dec., 1905; Discussion, 25. pp. 53–57, Jan., 1906.)—The buildings and equipment are described.

502. *Meteorological Results of Two Ascensions of Sounding Balloons in Castelfranco Veneto.* **A. Pochettino.** (Accad. Lincei, Atti, 14. pp. 577–584, Dec. 3, 1905. N. Cimento, 10. pp. 257–267, Oct., 1905.)—The course of the thermal gradient was studied by means of a self-registering apparatus attached to a tandem arrangement of two hydrogen balloons. The upper balloon was more inflated than the lower and at a certain altitude burst; during the descent the second balloon acted as a parachute. One of the ascensions was made during the solar eclipse (Aug. 30, 1905). D. H. J.

503. *Chemical and Geological History of the Atmosphere.* IV. **J. Stevenson.** (Phil. Mag. 11. pp. 226–237, Feb., 1906.)—In this, the fourth paper of a series on this subject [see Abstract No. 388 (1903) and Phil. Mag. 9. p. 88, 1905], the author has collected evidence as to whether the amount of CO_2 in the atmosphere is at present increasing or decreasing, and discusses the effect of the presence of a considerable amount of CO_2 on the age of the earth. Owing to the greater absorbing power of CO_2 for radiant heat, the earth would cool at a much lower rate than that used by Kelvin in calculating the age of the earth. S. G. S.

LIGHT.

504. *Instrument for compounding Vibrations in imitation of White Light.* **Rayleigh.** (Phil. Mag. 11. pp. 127–130, Jan., 1906.)—In discussions respecting the character of white light the author felt the want of some ready, even if rough, method of compounding several prescribed simple harmonic motions. The simple arrangement here described was used during lectures at the Royal Institution. A wooden batten, say 1 in. square and 5 ft. long, is so mounted horizontally as to be capable of movement only along its length. For this purpose it suffices to connect two points near the two ends, each by means of two thin wires with four points symmetrically situated in the roof. The movement of the batten along its length is controlled by a piece of spring-steel, against which the pointed extremity of the batten is held by rubber bands. Any force acting in the direction of the length of the batten produces a displacement proportional to the force. The tracing-point, by which the movements are recorded, is at the other end, as nearly as possible in the line joining the two points of attachment of the four suspending wires. The longitudinal forces are due to the vibrations of pendulums hanging from horizontal cross-pieces attached to the batten at their centres. The two ends of a wire or cord are attached to the extremities of a cross-piece, the bob of the pendulum being a mass (½ lb.) of lead carried at the middle of the cord. When set swinging the movements of the pendulums are thus parallel to the batten and tend to displace it along its length. In the author's apparatus the longest pendulum was 3 ft. 6 in. long. Under the influence of one pendulum the tracing-point describes a small simple harmonic motion along the length of the batten. In order to draw a curve of sines the smoked glass destined to receive the record should move vertically in its own plane. This was approximately attained by the use of a disc of glass in rotation about a horizontal axis, so placed that the tracing-point touched it near one end of the horizontal diam. of the glass. The motion was obtained by the use of a sand-clock—a device which was found to work better than might have been expected. Six pendulums were used whose frequencies were about as 5, 6, 7, 8, 9, 10, no exact adjustment being attempted. The paper closes with a note on the theory of the sand-clock, and includes photographic reproductions of the beautiful curves obtained with this very simple apparatus. E. H. B.

505. *Constitution of Natural Radiation.* **Rayleigh.** (Phil. Mag. 11. pp. 123–127, Jan., 1906.)—After an analytical discussion, taken from a kinematical standpoint, it is concluded that a Fourier element of radiation necessarily possesses in large degree the characteristic which Larmor associates with *white light* in contrast to *Röntgen radiation.* Of course, after the lapse of a sufficient time the final phases of the components lose all simple relation to the initial phases. The final phase of the resultant is then without relation to the initial phase, and the amplitudes may differ finitely, but in all probability within somewhat restricted limits. From this variation it seems that white light cannot be exempt. In saying that Fourier's theorem is competent to answer any question that may be raised respecting the action of a dispersive medium, it is taken for granted that the law of dispersion is given in its entirety. If there are any wave-lengths for which the behaviour of the medium is unknown, a corresponding uncertainty must attach to the fate of any aggregate in which these are included. Doubtless a complete statement of the law of dispersion may involve the case of wave-lengths for which the medium is not transparent. [See also Abstract No. 86 (1906).] C. P. B.

506. *Astigmatism, Coma, and Aberration.* **A. Gullstrand.** (Ann. d. Physik, 18. 5. pp. 941–978, Dec. 28, 1905.)—A discussion, chiefly on mathematical lines. The conoid of Sturm represents, not the general constitution of the beam, but one definite type. With singly refracting media and light originally homocentric, the conoid cannot represent a mathematically possible type, and experiment shows that the type which it, only to a certain extent, represents, is that with two planes of symmetry. In discussing the term astigmatism, the author takes it to mean a property of the beam along a given ray, but the astigmatism of an optical instrument is generally understood to mean something different. In medical optics, which deals with astigmatic eyes and sphero-cylindrical or toric lenses in which the axial beam is astigmatic, this is the property denoted; in the literature of constructive optics, on the other hand, by astigmatism is indicated that of an obliquely incident beam, often only that of a beam with infinitely small inclination to the axis, in which latter case the astigmatism of the instrument is measured by the difference in curvature of the two image surfaces on intersection with the axis. G. E. A.

507. *Diffraction Theory of Microscopic Vision.* **A. B. Porter.** (Phil. Mag. 11. pp. 154–166, Jan., 1906. Paper read before the Amer. Phys. Soc., April 22, 1905.)—E. Abbe proposed his diffraction theory of microscopic vision thirty-two years ago, but it is still to some exfent a matter of controversy among microscopists, and is perhaps less known to physicists than its importance warrants. The theory is briefly as follows: If a lens is to produce a truthful image of an illuminated object, it must have an aperture sufficient to transmit the whole of the diffraction pattern produced by the object; if but part of this diffraction pattern is transmitted the image will not truthfully represent the object, but will correspond to another (virtual) object whose diffraction pattern is identical with that portion which passes through the lens; if the structure of the object is so fine, or if the aperture of the lens is so narrow, that no part of the diffraction pattern due to the structure is transmitted by the lens, then the structure will be invisible no matter what magnification is used. Abbe and others have devised a number of interesting experiments to illustrate the theory, but the complete mathematical development has never been published. The particular case in which the object is a transmission grating of alternate opaque and transparent lines is, however, here treated by an application of Fourier's theorem and experiments illustrating various points are described. E. H. B.

508. *Interference Phenomenon in the Echelon Grating.* **E. Gehrcke.** (Ann. d. Physik, 18. 5. pp. 1074–1076, Dec. 28, 1905.)—An effect, noticed in an echelon grating when a long collimator slit was used, is reproduced by means of a simple two-step grating made by covering half of a slit of size 20 mm. × 2 mm. by a plane-parallel glass plate 5 mm. thick. Interference bands are seen to cross the usual ones at an angle which increases with the inclination of the incident rays to the normal of the plate. Photographs of the bands are given. G. E. A.

509. *Simple Explanation of Old Observations on the Chemical Action of Light.* **A. Guébhard.** (Journ. de Physique, 5. pp. 39–52, Jan., 1906.)—The agents of photographic excitation, whether chemical or physical, having only one mode of action, always operate additively, and the resulting impression can be expressed by a curve [see Abstract No. 2200 (1905)], of which the first part, almost tangential to the horizontal axis, corresponds to the effects of "continuation," the top or plateau to the "neutral state," the descending portion to the effects of "reversal," and the minimum in the neighbourhood of the axis to those of "destruction," after which the rise of the curve corresponds to what has been called "regeneration or restitution of sensitiveness," or the second reversal of Janssen. All spectral singularities, such as the *soi-disant* destructive action of red, can be explained by means of the curve. A series of bibliographical notes, relating to the effects referred to, is given at the end of the paper. G. E. A.

510. *Solarisation in Silver Bromide Films.* **H. Weisz.** (Zeitschr. Phys. Chem. 54. pp. 305–352, Jan. 23, 1906. Physikal.-chem. Inst. der Univ., Leipzig, March, 1905.)—The results of the research are given as follows: (1) The latent image on silver chloride and bromide consists of a solid solution of subhalogenide and (or) silver in silver halogenide. The solid solution is poor in subhalogenide (or silver) and strongly resists oxidising and reducing agents. (2) Any substance which is capable of forming solid solutions with silver can serve as the development germ for physical and also chemical development. Gold, platinum, rhodium, iridium, and silver sulphide (silver) can act as the development germ. (3) The power of the latent image to develop must depend on the capability of the solid solution described to form solid solutions with silver and silver subhalogenide. The silver halogen of the film is reduced to silver and silver subhalogenide. (4, 5) The cause of solarisation lies neither in the changing of all the silver bromide into a difficultly reducible modification, nor in the hindering of the diffusion of the developer by the changing of the binding medium by light (tanning). (6) Solarisation was produced on plates free from binding medium. (7) A sensitive method was worked out to demonstrate and compare cases of tanning. G. E. A.

511. *Lamellar Double Refraction.* **J. Friedel.** (Ann. d. Physik, 18. 5. pp. 1031–1048, Dec. 28, 1905. Extract from Inaug. Dissertation, Leipzig.)—Experiments are made which confirm Wiener's theoretical conclusion that a body built up of lamellæ of different refractive indices should behave like a uniaxial crystal which has an optic axis at right angles to the stratification [see Abstract No. 2188 (1904)]. A lamellar medium was built up from alternate layers of copper and silver iodides, the metals being deposited on a glass plate by kathodic pulverisation and then iodised. For one of the two mirrors from which successful results were obtained, it is given that the kathodes were reversed 100 times at one-minute intervals, so that a lamellar body was produced, consisting of 50 silver and 50 copper layers, the silver being about three times as thick as the copper. After iodisation the mirror had a yellowish colour. Proof of the theory was obtained by comparing the phase-differences produced in the constituents of a beam of plane-polarised light passed through the mirror with those calculated from the theory, the results agreeing to within 4 per cent., this being within the experimental error. The theory is therefore true for transparent media in which the thicknesses of the separate lamellæ lie between 15·9 and 42·5 $\mu\mu$. G. E. A.

512. *Fresnel's Theory of Double Refraction.* **J. Walker.** (Nature, 73. p. 319, Feb. 1, 1906.)—This note points out several cases in which Aldis, Preston, and Basset give misleading views of Fresnel's theory. First it is stated that, as erroneously quoted by these writers, an idea put forward as due to Fresnel, may be made to yield the bizarre result that frequency (*i.e.*, colour) of light is dependent upon the direction of vibration. Second, Preston and Basset, quoting from Verdet, state that one of the hypotheses on which Fresnel founded his theory is that the vibrations of polarised light are at right angles to the plane of polarisation, whereas, in the form of the theory finally presented by Fresnel, this appears, not as a basis, but as a direct consequence. On the other hand, the postulate that the ether is incompressible should be included among those of Fresnel. E. H. B.

513. *Artificial Double Refraction.* **T. H. Havelock.** (Roy. Soc., Proc. Ser. A. 77. pp. 170–182, Feb. 8, 1906.)—In 1902 Majorana [see Abstract No. 218 (1903)] described some new effects observed on placing in a uniform magnetic field certain solutions of dialysed iron, such as that of Bravais. The solution was found to become doubly refracting like a positive or negative uniaxal crystal, with its axis parallel to the lines of magnetic force. A formal theory of the phenomena given by Voigt consisted in adding to the ordinary electrical equations terms of the second order, representing the action of the magnetic field upon the natural vibrations of the medium. Previously, Kerr had obtained a negative double refraction by submitting to a magnetic field a medium composed of pure water containing invisibly fine particles of Fe_3O_4, his explanation of the effect being that the particles might be supposed to join together into filaments along the lines of magnetic force. It appears to be in this direction that the explanation of the phenomena is to be found. For Schmauss noticed that the effect could only be obtained in colloidal solutions, and Cotton and Mouton have determined that the effect is connected with the presence of ultramicroscopic particles [see Abstracts Nos. 1951 (1904) and 2046 (1905)]. Starting at this point, the author deals with the optical effect of spherical obstacles arranged in rectangular order on Rayleigh's method, the potential external to the spheres being expanded in terms of spherical harmonics. Double refraction due to mechanical stress is next dealt with, and finally that due to a magnetic field. It is concluded that the behaviour of solutions under mechanical stress is explainable as due to the possession of a certain amount of rigidity. The effects due to the magnetic field are supposed to be analogous to those due to mechanical stress. E. H. B.

514. *Double Refraction and Optical Rotation in Solid and Liquid Crystals.* **O. Lehmann.** (Ann. d. Physik, 18. 4. pp. 796–807, and pp. 808–810, Dec. 12, 1905.)—A wedge of gypsum in certain positions shows coloured strips between crossed nicols, whilst a lens shows coloured rings. In the case of liquid crystals, a similar method can be used by enclosing the liquid between a plate and a concave lens, the double refraction being determined from the relationship between the diam. of the rings and the thickness of the layer. Data are given showing the extent of the double-refraction in the case of ethyl *p*-azoxybenzoate (which is nearly six times as great in the liquid as in the solid state), *p*-azoxyphenetol, *p*-azoxyanisol, and azoxyanisol-phenetol. The rings only occur when the liquid crystal has been allowed to form from solid crystals of uniform orientation or has been rendered homogeneous by

deformation. If this is prevented by the addition of a trace of solvent, a different series of rings is formed depending on rotatory polarisation. In the case of a mixture of *p*-azoxyphenetol and *p*-azoxyanisol the rotation of the plane of polarisation may amount to 180°, in which case the field remains quite dark when crossed nicols are used. T. M. L.

515. *Faraday and Kerr Effects in the Infra-red Spectrum.* **L. R. Ingersoll.** (Phil. Mag. 11. pp. 41–72, Jan., 1906. Thesis submitted to Univ. of Wisconsin, 1905.)—The dependence of the magnetic rotation on wave-length is studied in the infra-red under these two aspects by a bolometer method. All the other conditions—field strength, length of carbon bisulphide tube and temperature—are kept constant. The results may be summarised as follows: 1. The magnetic rotatory dispersion of carbon bisulphide over a range of spectrum extending from the sodium lines to $\lambda = 4{\cdot}3\,\mu$ is found to be correctly represented by a formula which takes account of the absorption band beyond $8\,\mu$, showing that an infra-red absorption band may affect the rotatory dispersion over a considerable range of spectrum. 2. The magnetic metals and magnetite show, after wave-length $1\,\mu$ in the infra-red, a decrease of the Kerr rotation, with increase of wave-length. The complete rotatory dispersion-curves, made by supplementing the results for the infra-red by existing observations for the visible spectrum, show a marked resemblance to a typical dispersion-curve in the region of an absorption band, indicating the existence in metals of something analogous to a region of resonance-absorption, extending over the visible spectrum. 3. In the cases of nickel and magnetite the rotation appears to vanish for a particular wave-length and then change in sign. The Kerr rotation for the Heusler's alloy, if it exists at all, is less than 1/10 of that for iron or steel. 4. Although the results do not allow of definite conclusions as to whether the hypothesis of molecular currents, or of the Hall-effect, should be accepted in explaining magnetic rotation, the indications are that the latter theory holds for CS_2—*i.e.*, it presents a case analogous to that of sodium vapour, while the curves of the magnetic metals require the former explanation, though the reversal of nickel might be considered as evidence for the Hall-effect. J. W. P.

516. *Elliptic Polarisation produced by Liquid Mixtures.* **J. Chaudier.** (Comptes Rendus, 142. pp. 201–203, Jan. 22, 1906.)—The mixtures are prepared by adding the same weight of powdered boric acid to equal volumes of the different organic liquids employed. The elliptic polarisation produced by an electric field is such that the retardation is proportional to the thickness of liquid traversed by the light and subjected to the action of the field. The retardation increases rapidly with the field, and for a terebene mixture reaches a constant value of 0·18λ for plates 6·2 cm. apart at a p.d. of 91 electrostatic units. Results are given for other nine liquids, and it is concluded that the liquid mixtures, when placed in uniform electric and magnetic fields, polarise the light elliptically in the same proportions. The effect of weight is analogous but much feebler. The action of the fields appears to be directive, the orientation of the particles being due to their crystalline structure and their shape. [See also Abstract No. 1666 (1904).] G. E. A.

517. *Relative Intensities of Metal and Gas Spectra from Electrically Conducting Gases.* **P. G. Nutting.** (Bureau of Standards, Bull. 1. 3. pp. 399–416, Nov., 1905.)—This paper is a continuation of the author's investigation

into the spectra of mixed gases, and he finds that the same general laws hold good in the present case as before [see Abstract No. 1417 (1904)], namely, that the relative intensity of the spectrum of a gas present in a mixture is increased by increasing the relative amount present, that, other things being equal, in a steady discharge the spectrum of that component of a mixture having greater atomic weight will be brighter, and that in a disruptive or forced oscillatory discharge the effect due to atomic weight is less. The amount of electrode vapour present depends upon the current and electrode fall of potential. This electrode-fall is again a function of other variables; it is nearly proportional to the current, and varies slightly with the pressure upon the gas and the temperature of the electrodes. To obtain the pure spectrum of the gas it is necessary (1) to use small current density at the electrodes; (2) that the electrodes be of some metal showing small vaporisation, *e.g.*, Al; (3) that the electrodes be a considerable distance apart and only the middle portion of the discharge be used. To obtain the pure electrode spectrum it is necessary to have large current density and the electrodes near together. E. C. C. B.

518. *Satellites of the Lines of the Mercury Spectrum.* **E. Gehrcke** and **O. v. Baeyer.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 50. pp. 1037–1042, Dec. 7, 1905. Communication from the Physikal. Techn. Reichsanstalt.)—The lines of the mercury spectrum have been shown to be very complicated, and the authors have again investigated their constitution, using the method of interference points previously described [Abstract No. 1752 (1905)]. Certain sources of error were in this way eliminated. The results are given in the paper, and it may be remarked that some of the satellites previously observed [Abstract No. 1362 (1903)] are now shown to be ghosts and to have no real existence. E. C. C. B.

519. *Spectra of the different Phases of the Oscillatory Spark Discharge.* **G. A. Hemsalech.** (Comptes Rendus, 141. pp. 1227–1230, Dec. 26, 1905.)—The author has described a method of separating the different oscillations taking place in the spark discharge by means of a current of air [see Abstract No. 1272 (1905)]. In the present paper are described the results obtained by photographing the various oscillations. Inasmuch as the initial discharge shows the line spectrum of air, and the subsequent discharges the band spectrum, the author concludes the former is due to the discharge through non-ionised air and the latter to ionised air. Further, he finds that one single oscillation is capable of producing luminosity in the metallic vapour from the electrodes. E. C. C. B.

520. *Variation with Temperature in Emission Spectra of Electric Lamps.* **P. Vaillant.** (Comptes Rendus, 142. pp. 81–83, Jan. 8, 1906.)—A spectrophotometric determination of the variation in intensity of the yellow, green, and blue ($\lambda = 492$) lines in the spectrum of the Cooper Hewitt mercury lamp. It is found that with increase in the current the increase in the intensity of the lines is greater as the wave-length increases. This is opposite to the effect observed with the emission spectra of solids. Some comparative results are added for the carbon- and tantalum-filament incandescent lamps and the Nernst lamp. E. C. C. B.

521. *Spectrum of the Light from Canal Rays in Nitrogen and Hydrogen.* **J. Stark** and **W. Hermann.** (Phys. Zeitschr. 7. pp. 92–97, Feb. 1,

1906.)—The spectra, obtained by means of the prism spectrograph previously described [Abstract No. 1210 (1905)], of the positive column, kathode glow, and canal rays produced in nitrogen are exhibited together, and it is at once observable that there are bands in the spectrum of the negative glow that are not present in the case of the positive column; also in case of the canal rays the spectrum, although much fainter, is a line spectrum, and in addition to the above the lines of hydrogen, mercury, and aluminium are present. The Al lines are due to the Al kathode employed. It is also found that the spectrum produced by the canal rays is more intense, the greater the kathodic p.d. and the resulting velocity of the rays. According to the authors, the line spectrum is due to the positive ions of the canal rays [see Abstract No. 297 (1906)], and it is pointed out that in studying the deflection of the rays in a magnetic or electrostatic field the presence of the ions of H, Hg, and Al in the nitrogen will give rise to dispersion of the bundle of rays owing to the varying masses of the ions; the H ions will be deflected the most and the Hg ions the least. Further, the effect of the light-pressure due to the emission of light-rays by the ions travelling at the velocity indicated by the Doppler-effect is equivalent to an apparent increase of the mass of the ion and must be taken into account in determining this mass by the method of deviation. That the line spectrum cannot be obtained when using the α-rays from a radio-active substance is explained by the fact that the ions have velocities varying from 0 to $1{\cdot}6 \times 10^9$ cm./sec., and hence exhibit the Doppler-effect to a varying extent, causing broadening and indistinctness of the bands. In order to obtain a line spectrum it would be necessary to use a bundle of parallel rays and receive the light from it in a direction normal to its path.

S. G. S.

522. *Tribo-Luminescence.* **C. S. S. Webster.** (Chem. News, 92. p. 185, Oct. 20, 1905.)—When large crystals of artificially prepared salicylic acid, placed on flannel, are crushed against a glass plate in the dark and viewed from the other side, many brilliant flashes are seen to be emitted. With the natural acid very few flashes appear. A similar result is obtained if a little of the acid is violently shaken up in a bottle. Both artificial and natural salicylic acids respond to radium more than is usually the case with organic compounds exhibiting tribo-luminescence of the first order. Hard substances, both organic and inorganic, may be conveniently examined for tribo-luminescence by either holding them in the fingers or placing them on flannel and rubbing them on a sheet of ground glass, the effect being viewed from the other side; the glass may be fitted in a wooden frame with a handle and held like a hand-mirror.

T. H. P.

523. *Kathodic Phosphorescence of Europium.* **G. Urbain.** (Comptes Rendus, 142. pp. 205–207, Jan. 22, 1906.)—The europiums extracted from monazite earths, xenotime and pitch blende, had the same atomic weight [see Abstract No. 1579 (1904)], the same absorption spectra, and the same spark spectra. The pure oxide of europium is not phosphorescent under kathodic radiation, but when diluted by lime in the proportion of 1 part of Eu_2O_3 to 99 of CaO, a red phosphorescence is produced. Under certain conditions a pink phosphorescence is obtained, and the spectra of consecutive fractions, obtained during the separation of gadolinium, are modified gradually as if the europium was a mixture of at least two phosphorescent earths. Similar variations of the spectrum are found when the europium is diluted with lime.

G. E. A.

524. *Slow Radiant Matter.* **N. Piltschikoff.** (Phys. Zeitschr. 7. pp. 69–70, Jan. 15, 1906. Paper read before the Liége Congrès de Radiologie. From the French.)—In 1842 Moser observed a species of radiation proceeding from clean metallic surfaces, and capable of impressing the photographic plate. This radiation is called "Moser radiation" by the author. He finds that some metals, like Fe, Mn, Al, Zn, Cd, and colloidal silver reduce silver bromide, and calls the radiation emitted by them "positive." Others, like osmium and tantalum, reverse the process; the Moser rays of copper and brass are neutral, and gold, iridium, and mercury emit no Moser rays at all. The rays are not perceptibly deflected by magnetic or electric fields, but are easily deflected by an air current. They are not simply metallic vapours, since the rays from platinum are capable of traversing a sheet of silver without forming an alloy. The rays cannot be hydrogen peroxide, since their properties differ from one metal to another. The author believes that the Moser rays consist of heavy and slowly-moving ions, and that they are closely akin to emanation. They may be useful in metallo-therapeutics. E. E. F.

525. N-*rays.* **Mascart.** (Comptes Rendus, 142. pp. 122–124, Jan. 15, 1906.)—The author repeated Blondlot's experiment on the refraction of *n*-rays emitted by a Nernst lamp by means of an aluminium prism, employing special precautions and several trained observers. The spectrum shows a series of maxima not very sharply defined. The screen bearing the line of sulphide used as a detector was mounted on a dividing machine, and an assistant took down the readings as the observer fixed the microscope upon a maximum. Blondlot himself took some of the observations, and his readings were always consistent within 2′ of the deviation. The other observers were Gutton, Virtz, and the author himself. From 4 to 7 maxima were observed, and the mean deviation was 30°. E. E. F.

526. *Photographic Action of* N-*rays on the Oscillatory Spark.* **C. Gutton.** (Comptes Rendus, 142. pp. 145–149, Jan. 15, 1906.)—The author describes experiments which confirm the results of Blondlot, that the *n*-rays produce a diminution of the brightness of an electric spark discharge [see Abstract No. 83 (1905)]. A photographic method is employed. The primary spark is produced by a Holtz machine, having one pole earthed, driven by an electric motor, and takes place between German silver spark-balls forming part of an oscillatory circuit. Leads are taken to the secondary spark-gap (German silver points 1/30 or 1/40 mm. apart) placed in a blackened wooden box shielded by a double lead screen from the effects of the primary spark-gap. A small opening allows the light from this spark to fall upon a piece of ground glass, the diffused image of which light is recorded on a photographic plate. As source of *n*-rays a Nernst lamp in a metal lantern is placed 45 cm. behind the primary spark-gap, the rays from the lamp having to traverse two paper screens and an earthed sheet of aluminium. A zinc screen covered with moistened filter paper (opaque to *n*-rays) can be placed so as to intercept the beam falling upon the primary gap. Thirty-seven series of plates obtained by giving a 30-sec. exposure with the *n*-rays acting (on one part of the plate), shifting the plate and exposing for a further 30 sec. with the moist paper screen interposed, and repeating this process so that a 1-min. exposure under both circumstances was given, all show the very markedly more feeble image produced on the plate when the *n*-rays are acting on the primary spark-gap. The plates used were Jougla (green band) and Lumière (blue band). [See also Abstract No. 975 (1905).] L. H. W.

527. *Radio-activity of Polonium.* **Mme. S. Curie.** (Comptes Rendus, 142. pp. 273–276, Jan. 29, 1906. Phys. Zeitschr. 7. pp. 146–148, March 1, 1906.) —A series of experiments, extending over six months, is described, the object of which was to determine the law of diminution of the activity of polonium with time. A convenient quantity of poloniferous oxide of bismuth (of mean activity 250 times that of uranium) was placed in a shallow circular cavity in the centre of a circular metallic disc. The intensity of the radiation was measured by the saturation current produced in a condenser. The results obtained were as follows: The intensity of the radiation diminishes with respect to the time according to a simple exponential law. If I_0 is the initial intensity, I the intensity at time t, a a constant, $I = I_0 e^{-at}$. If t is expressed in days, $a = 0{\cdot}00495$; the intensity diminishes to half value in about 140 days. The values obtained from this formula do not differ from the observed values by more than 3 per cent. Plotting time against log I, straight lines are obtained. Since the constant a in the formula is the same as that obtained by Marckwald for his *radio-tellurium,* the author concludes that radiotellurium must be identical with polonium. [See, however, Abstract No. 96 (1906).] A. W.

528. *Radiation from Ordinary Materials.* **N. R. Campbell.** (Phil. Mag. 11. pp. 206–226, Feb., 1906.)—The method of experiment has already been described in a previous paper [Abstract No. 1219 (1905)], but the apparatus is modified; in order to get over the uncertainty introduced by the corners of the box, a guard-ring arrangement is used, and the current is determined in absolute measure by balancing it against a known current in a vessel containing uranium, the capacity used being also determined in absolute measure. Several metals are examined, and in all cases two series of readings are taken—the first with the thick lead screens cutting off two-thirds of the external radiation, and the second without these screens. The results are exhibited in curves, the currents × 10^5 being taken as ordinates and distance of parallel sides as abscissæ. In order to interpret the results, the absorption of the easily absorbable radiation (α-rays) from the substance is assumed to take place according to a law given by W. H. Bragg [see Abstract No. 355 (1905)], and not according to an exponential law, as was previously assumed. According to Bragg, a positive ion travels a distance a in air, producing ionisation at a constant rate until it has travelled this distance and then ceasing to produce ionisation; in any other substance the path varies inversely as the density. Assuming this law, the author calculates the amount of ionisation between two parallel plates separated by distance x and finds it to be—

$$y = p\frac{4x}{a}\left\{1 - \frac{x}{a}\left(\frac{3}{4} - \frac{1}{2}\log\frac{x}{a}\right)\right\} + v\,abx + \mu x,$$

where p is the ionisation due to a surface S of an infinite state of the material, $a \times b \times x$ the dimensions of the space, so that $v\,abx$ is an ionisation due to the more penetrating radiation, and μx is the ionisation due to the wire gauze used, and which is proportional to its area, being determined by an auxiliary experiment. When the lead screens are removed a penetrating radiation and the penetrating part of a secondary excited radiation will have to be added ($v'\,abx$) and an absorbable radiation which the author shows to be absorbed according to an exponential law; thus to the unscreened curve must be added $y = p'(1 - e^{-\lambda x}) + v'\,abx$. By plotting the "screened" and "unscreened" curves and subtracting the former from the latter, the screening effect could be found; then subtracting one-half of this (2/3 only if external radiation is absorbed by lead screens) from the former, the curve exhibiting the effects of the intrinsic radiation could be found, and from these p, v, and a determined. The following table exhibits the results:—

Material.	s.	s'.	V.	V'.	a.	λ.	$\frac{v_1 - v_2}{v_1}$.	$\frac{p_1 - p_2}{p_1}$.
Lead (1)	270	0	10·2	14·2	12·0[1] 12·5[2]	...	0·39	0
Lead (2)	260	0	13·4	26·3	12·5[1] 12·0[2]	...	0·44	0
Copper (1)	103	160	2·2	22·0	9·0	0·6	0·47	0·29
Copper (2)	110	91	8·1	27·4	9·0	0·5	0·51	0·29
Aluminium	117	0	14·8	17·0	6·0[1] 6·5[2]	...	0·36	0
Tin	144	156	3·1	18·9	9·0	0·5	0·57	0·35
Silver	146	146	25·5	17·0	8·5	0·9	0·27	0·33
Platinum	74	411	17·3	14·1	12·0	0·4	0·30	0·56
Gold	78	169	10·4	16·8	10·0	0·6	0·43	0·46
Zinc	72	51	15·4	16·8	10·0	0·5	0·33	0·28
Iron	119	124	12·3	10·5	13·0	0·5	0·31	0·34

[1] Calculated from "screened" curve. [2] Calculated from "unscreened" curve.

s and s' are the number of ions produced per sec. by easily absorbable radiations from 1 sq. cm. of surface of metal (intrinsic and secondary respectively), V and V' number of ions produced per sec. by penetrating radiations, a Bragg's constant, λ coefficient of absorption of easily absorbable secondary radiation. From the variation of Bragg's constant the author concludes that the emission of ionising rays is an inherent property of the substance and is not due to a radio-active impurity (for radium $a = 7$). Further, 1,500 gm. of lead were dissolved in nitric acid and boiled to expel any emanation. On allowing this to stand for 24 days, no emanation could be detected. If "intrinsic" radiation were really due to external radiation not completely cut off by the screens, we should expect the surface radiation to be cut off in the same ratio as the volume radiation, and we should have $(v_1 - v_2)/v_1 = (p_1 - p_2)/p_1$. That this is not the case is seen from the last two columns of the table. S. G. S.

529. *Explosion of Radium Tubes.* **J. Precht.** (Phys. Zeitschr. 7. pp. 33–34, Jan. 15, 1906. Phys. Inst. d. techn. Hochschule, Hannover, Dec. 4, 1905.) —On Dec. 27, 1904, the author sealed up 25 mgm. of purest radium bromide in a glass tube of 2 mm. internal diam. and 0·5 mm. thickness of wall. It was finely powdered and desiccated. In Nov., 1905, it was several times immersed in liquid air. Three minutes after it had been removed from the bath and laid on a wooden table the tube exploded spontaneously, the glass being broken up into almost microscopic fragments. The radium was visible in the dark like a starry sky, and was recovered piecemeal. The pressure, no doubt due to emanation, must have been 20 atmospheres. [See also Dorn, Abstract No. 1121 (1904).] E. E. F.

530. *Energy of Secondary Radiation.* **J. A. McClelland.** (Roy. Dublin Soc., Trans. 9. 2. pp. 9–26, Feb. 6, 1906.)—In previous papers [see Abstracts Nos. 992 and 1397 (1905)] the author has studied the secondary radiation emitted by substances when exposed to the β- and γ-rays from radium. This secondary radiation consists of negatively-charged particles similar to the β-rays; and a simple relation has been found to exist between the intensity of the radiation and the atomic weight of the substance emitting it, the

secondary radiation from all the elements tested increasing with the atomic weight of the element. In the present paper the energy of the secondary radiation is compared with that of the primary radiation producing it. By preliminary experiments it was shown that when β-rays from radium fall on a metal plate no easily-absorbed secondary radiation comparable in intensity to the incident β-rays is produced, so that for all practical purposes the secondary radiation consists entirely of β-rays very similar in every way to the incident rays that produce them. Thus the energy of the two radiations may be compared by measuring their ionising powers under similar conditions. This comparison was made in the case of lead; the relative intensities of radiation from a large number of elements had been previously determined. The ionisation produced in an ionisation vessel by the direct β-rays from radium was compared with the ionisation produced in the same vessel by the secondary radiation given off from a lead plate struck by the β-rays, the vessel being placed in the second case in such a position that the rays from the lead plate passed into it along a path making an angle of 45° with the direction of the β-rays incident normally upon the plate. The ionisation chamber consisted of a brass tube 20 cm. long and 7·5 cm. in diam., with an insulated brass rod fixed along its axis and connected to an electrometer. The end of the tube through which the radiation passed was covered with gold-leaf. The tube was kept at a high potential, and the saturation current to the rod measured in the usual way with the electrometer. The variation of the secondary radiation with the angle at which the ionisation vessel was placed relatively to the lead plate was found and allowed for. The ratio of the total energy of the secondary radiation given off in all directions to that of the primary radiation absorbed by the plate was then calculated, and found to be 0·49. A table is given showing the value of this ratio for various substances, for which the relative intensities of the secondary radiation had been previously measured. The calculated percentage of the incident energy absorbed which is set free again as secondary radiation is also given. This percentage is 88·5 in the case of lead and 45 for carbon, the element of lowest atomic weight tested. It follows from the results obtained that the actual coefficient of absorption for lead is only one-third of what the coefficient would be if there were no secondary radiation; or the average distance to which the incident β-particles penetrate into the lead is only one-third of the distance they appear to penetrate, due to the successive generation of other β-particles. In the usual method of determining the coefficient of absorption by measuring the intensity of the radiation before and after the interposition of a plate of the substance tested and then calculating the coefficient, the effect of secondary radiation should be allowed for. The rapid decrease of the coefficient of absorption of β-rays as the thickness traversed increases has been taken to show the marked heterogeneity of the rays as regards penetrating power, but even with perfectly homogeneous radiation, variation of the coefficient of absorption with the thickness of substance used would occur. Thus the β-rays from radium are not so heterogeneous as the experiments on their absorption by matter made in the usual way would indicate.

J. J. S.

REFERENCES.

531. *Vision.* **W. Peddie.** (Roy. Soc. Edinburgh, Proc. 25. pp. 948–951, 1904–1905.)—In opposition to generally accepted views, it appears that direct vision, when unobstructed by patches of self-colour in the eye, is most effective for perception of small luminous objects (stars). L. H. W.

532. *Concave Grating Spectroscope.* **G. Eberhard.** (Zeitschr. Instrumentenk. 25. pp. 371–382, Dec., 1905. Astrophys. Observatorium, Potsdam.)—The author describes the installation of a large Rowland concave grating mounted according to the plan suggested by Abney, in which the grating and photographic plate are rigidly fixed at the distance of the radius of curvature of the grating, while the successive orders of spectra are brought into focus by moving the slit along a circle whose radius is equal to the focus or half the radius. An analysis of various instrumental errors is appended and partly discussed. C. P. B.

533. *Metallic Reflection.* **R. Sissingh.** (Konink. Akad. Wetensch. Amsterdam, Versl. 14. pp. 506–509, Dec. 6, 1905. Proc. 8. pp. 486–489, Dec. 21, 1905.)—In this paper the fundamental equations of metallic reflection are derived from Cauchy's theory which introduces a complex index of refraction. [See also Abstract No. 2204 (1905).] E. H. B.

534. *Optical Analogy of the Periodogram.* **A. Schuster.** (Roy. Soc., Proc. Ser. A. 77. pp. 136–140, Feb. 8, 1906.)—The periodogram supplies by calculation the transformation which the spectroscope instrumentally impresses on a luminous disturbance. A detailed analytical development is given, showing the advantages of the method. One of the principal uses of the periodogram system is that it gives a measure of the resolving power necessary to isolate a true homogeneous period from the irregular fluctuations. C. P. B.

535. *Magneto-optic Properties of Colloidal Solutions of Iron Hydroxide.* **A. Cotton** and **H. Mouton.** (Comptes Rendus, 142. pp. 203–205, Jan. 22, 1906.)—A continuation of the research described in Abstract No. 2046 (1905), giving the effect of a magnetic field on light propagated through the liquid parallel to the lines of force. The colloidal solution, when solidified in a magnetic field by the addition of gelatine, retains its power to act on polarised light; and the presence of magnetic particles in the solution can be made evident without the use of a microscope. G. E. A.

536. *Isolation of Terbium.* **G. Urbain.** (Comptes Rendus, 141. pp. 521–523, Sept. 18, 1905.)—The author has succeeded in isolating pure terbia by fractional crystallisation of the nickel double nitrate. The absorption spectrum of the neutral chloride is described in the paper, and the atomic weight of the metal is found to be 159·2 (O=16). E. C. C. B.

537. *Infra-red Emission Spectra.* **W. W. Coblentz.** (Phys. Rev. 22. pp. 1–30, Jan., 1906. Extract from a memoir submitted to the Carnegie Inst. of Washington.)—This paper contains a fuller account of the author's work upon infra-red emission spectra which has already been published in part. [See Abstracts Nos. 1001 and 2048 (1905).] A valuable theoretical discussion upon the results is given in the paper. E. C. C. B.

538. *Absorption and Emission Lines of Gases.* **H. A. Lorentz.** (Konink. Akad. Wetensch. Amsterdam, Versl. 14. pp. 577–581, Jan. 10, 1906. Proc. 8. pp. 591–611, Jan. 25, 1906.)—A mathematical paper dealing with the spectra of gases on the electron theory with special reference to the recent work of Hallo [see Abstract No. 1414 (1905)], with which the present theory is in fair agreement. E. H. B.

539. *Influence of Radium on the Respiration of Germinating Grains.* **H. Micheels** and **P. de Heen.** (Bull. Acad. Roy. Belg. pp. 29–34, 1905.)—The radiations are found to diminish the amount of CO_2 evolved.

540. *Radium and Photographic Plates.* **U. Behn.** (Ann. d. Physik, 17. 4. pp. 772–774, Aug. 22, 1905.)—In reference to Petri's results [see Abstract No. 1581 (1905)] a certain breadth of the radiating substance will produce half shadows which cause the apparent protuberances and bridges. Ordinary light presents a perfect analogy as shown by photographs and as illustrated by simply approximating the tip of the thumb and the tip of the forefinger immediately in front of the eye against a window. **G. W. A. Kahlbaum.** (Ibid. 17. 5. pp. 1009–1011, Sept. 26, 1905.) —Kahlbaum gives an illustration similar to those of Petri, but made in 1902: concludes adversely to Petri's explanation, but is not able to propound another. A. D.

541. *Analysis of the Radiation from Radio-active Substances.* **H. Becquerel.** Archives d'Él. Médicale, 13. pp. 811–829, Nov. 10, 1905.)—A general account of the methods employed to separate the different rays emitted by radio-active bodies, followed by concise sections dealing in turn with the α-, β-, and γ-rays, and concluding with a summary.

542. *Action of Radium Salts on Gelatine.* **W. A. D. Rudge.** (Nature, 73. pp. 78–79, Nov. 23, 1905.)—Lead and strontium salts produce the same results upon gelatine as is the case with radium. The "growths" appear to be simply a precipitate of some insoluble body formed by the action of the salts used upon the gelatine. J. J. S.

543. *Screening Effect of Rock Salt for Becquerel Rays.* **J. Elster** and **H. Geitel.** (Phys. Zeitschr. 6. pp. 733–737, Nov. 1, 1905.)—The spontaneous ionisation in a closed space which is surrounded by rock salt is much less than when the rock salt is removed. Whether this is because this substance is opaque to external radiations, or whether it is because of its freedom from all traces of radio-active substances, is not altogether clear. R. S. W.

544. *The α-particles of Radium.* **W. H. Bragg.** (Phil. Mag. 10. pp. 600–602, Nov., 1905. Phys. Zeitschr. 7. pp. 143–146, March 1, 1906.)—A discussion of some of the author's results in the light of more recent knowledge [see Abstract No. 2061 (1905)]. If the ionisation varies inversely as the nth power of the velocity, n is found nearly equal to 2. R. S. W.

545. *Luminescence of Radium Bromide.* **R. Pohl.** (Deutsch. Phys. Gesell., Verh. 7. 24. pp. 458–464, Dec. 30, 1905. Phys. Inst. d. Univ., Berlin, Nov., 1905.)—It was possible that the effect on the photographic plate in the experiments of B. Walter and the author [see Abstract No. 103 (1906)] might be due to fluorescence of the quartz window in the neighbourhood of the radium salt. Further experiments have shown that this is not the case, but that the air above the radium preparation actually becomes luminous. T. M. L.

546. *Some Properties of Actinium.* **A. Debierne.** (Phys. Zeitschr. 7. pp. 14–16, Jan. 1, 1906. Lab. Chim.-Phys. de Sorbonne, Paris. From the French.)—A *résumé* of recent work on the emanations, radiations, and transformations exhibited by radio-active substances. [See also Abstracts Nos. 1883 and 1884 (1905).] E. H. B.

547. *Scintillations produced by β-rays.* (Nature, 73. p. 341, Feb. 8, 1906.)—Experiments are described which give indications that the β-rays from radium may cause scintillations on a fluorescent screen of barium platinocyanide. A faint fluorescent glow of an unsteady and flickering character was observed. J. J. S.

HEAT.

548. *Anchor Ice.* **H. T. Barnes.** (Amer. Soc. Mech. Engin., Trans. vol. 26, 1905. Eng. News, 53. pp. 627–629, June 15, 1905. Abstract.)—Below 40° C. "water" is a solution of ice in water; as the temperature rises from 0° to 40° the specific heat falls, *i.e.*, less and less heat is being expended in converting the dissolved ice into liquid water. Heat is apparently lost by radiation through the water of a river; *i.e.*, the heat so lost must lie below the broad absorption band to which water is adiathermanous: for anchor ice is formed at the bottom of rivers by direct freezing there. Freezing and melting require time; if heat be too rapidly withdrawn or imparted, the temperature of a mixture of ice and water may go slightly below or above 0° C. The thickness d of ice, in cm., which will form in T seconds under an air-temperature $-\theta°$ (L being the latent heat in calories, s the density of ice (0·9166), K the thermal conductivity $= 0·0057$ cal. per sq. cm. per sec. per degree) is given by the expression $T = (Lsd/K\theta)[1 + (d/2)]$. Applications to certain problems of river engineering are considered. A. D.

549. *Emission Power of the Welsbach Mantle.* **O. Lummer** and **E. Pringsheim.** (Phys. Zeitschr. 7. pp. 89–92, Feb. 1, 1906. Phys. Inst. d. Univ., Breslau, Dec., 1905. Écl. Électr. 46. pp. 344–346, March 3, 1906.)—In a recent paper Rubens calculated the temperature of the Welsbach mantle by direct comparison with an optical pyrometer [see Abstract No. 91 (1906)]. The authors point out that this measurement is quite valueless. Rubens only obtained the temperature which an absolutely black body would have when emitting energy similar to that of the mantle. As nothing is known of the emission power of the mantle, no idea of its real temperature can be formed from its "black body temperature." Rubens made the unwarranted assumption that the emission power of the mantle is equal to that of the black body. The true temperature must be much higher than that Rubens gave in his paper (1,800° abs.). E. C. C. B.

550. *Kinetics of Extreme States of Aggregation.* **E. Bose.** (Zeitschr. Elektrochem. 11. pp. 742–744, Oct. 27, 1905. Paper read before the 12 Hauptversamml. d. Deutsch. Bunsen-Gesell., Karlsruhe, June 1–4, 1905.)—The author communicates the results of calculations dealing with the phenomena of conduction of heat and viscosity in highly rarefied gases, in the case where the distance between the plates, across which heat is conducted or between which flow of matter occurs, is very much smaller than the mean free path of the molecules. It is found that in the case of heat-conduction the energy-flow per unit of surface per unit of time is proportional to the pressure of the gas, to the temperature-difference between the walls, and to the square root of the product of the density of the gas at 760 mm. and the absolute temperature of the gas. In the case of a moving plate the loss of energy per unit of time per unit of surface is found to be proportional to the pressure of the gas, approximately proportional to the square of the velocity of the plate, and proportional to the square root of the product of normal density and absolute temperature. By a consideration of the kinetic molecular equilibrium between the solid wall and the dilute gas, the author arrives at values for the mean velocity and amplitude of the oscillations of the molecules of the solid wall, which are compared with results deduced by Drude from the electronic theory. F. G. D.

551. *Characteristic Equation.* I. *Orthometric State.* II. *Isopentane.* **A. Batschinski.** (Ann. d. Physik, 19. 2. pp. 307–332, Feb. 8, 1906.)—For a substance conforming to van der Waals' characteristic, the author calls those states *orthometric,* for which $pv = \mathrm{RT}$; the orthometric density is thus a linear function of T, being given by $1/b - \mathrm{RT}/a$, and this Amagat's experiments show to be $0{\cdot}7586 - 0{\cdot}000923\,t$ in the case of ethyl oxide. Since the critical volume and temperature of ethyl oxide are 3·814 and 467·4, this gives $3{\cdot}854 - 1{\cdot}645\,\tau$ for the *reduced* orthometric density, where τ is the reduced temperature [the author, by confusing t with T, obtains 2·893 for 3·854; further, van der Waals' characteristic would give $3 - 8\tau/9$]. From Young's work on isopentane the author deduces a characteristic for this substance of the form $pv = \mathrm{RT} - (\mathrm{A}v - \mathrm{B})(v - k)/kv(v^2 - s)$, where A, B, k, s are more or less complicated functions of the temperature. R. E. B.

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552. *Latent Heat of Ice.* **A. Leduc.** (Comptes Rendus, 142. pp. 46–48, Jan. 2, 1906.)—The author discusses the values previously found for this constant and, after introducing a correction in the specific mass of ice, arrives at the value of 79·2 calories; the calorie adopted refers to water at 15°. E. C. C. B.

553. *Calculation of Efficiency.* **G. Andrault.** (Journ. de Physique, 5. pp. 97–98, Feb., 1906.)—The author calculates the ratio of the work done to the heat taken in at the highest temperature in the case of an engine employing a perfect gas with a cycle of two isothermals and two isopiestics, and deems that he has thereby, once for all and simply, evaluated the maximum efficiency of thermal engines utilising two sources at constant temperature! [He does not realise the conditions of his problem, and knows nothing of Rankine's isodiabatic lines.] R. E. B.

554. *Thermometry.* **H. Hausrath.** (Ann. d. Physik, 17. 4. pp. 735–743, Aug. 22, 1905. Elektrot. Inst. d. techn. Hochschule Karlsruhe.)—Methods of measurement of small temperature differences with thermo-elements and a compensation apparatus with constant small compensation-resistance, under a constant auxiliary current. A. D.

555. *Thermodynamics and Kinetic Theories.* **H. A. Lorentz.** (Soc. Franç. Phys., Bull. 1. pp. 35–63, 1905. Journ. de Physique, 4. pp. 533–560, Aug., 1905.)—The author contrasts and compares the thermodynamical and kinetic methods in their application to a variety of interesting problems. The principal subjects treated of are: Helmholtz's monocyclic systems; Kinetic view of a gaseous system subjected to the action of gravity; Variation of osmotic pressure with height in a column of a dilute solution subjected to the action of gravity; Thermoelectric phenomena from the point of view of the electron theory; Radiation of heat treated from the same standpoint. The author's conclusion is that kinetic (molecular, atomic, and electronic) theories and ways of thinking must be assiduously cultivated side by side with the thermodynamical method. F. G. D.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

556. *Electrical Vibrations and Constitution of Atoms.* **Rayleigh.** (Phil. Mag. 11. pp. 117–123, Jan., 1906.)—In illustration of the view suggested by Kelvin, that an atom may be represented by a number of negatively charged corpuscles, enclosed in a sphere of uniform positive electrification, J. J. Thomson has given some valuable calculations of the stability of a ring of such electrons, uniformly spaced, and either at rest or revolving about a central axis. The corpuscles are supposed to repel one another according to the law of the inverse square of the distance and to be endowed with inertia, which may, however, be the inertia of the ether in the immediate neighbourhood of such corpuscle. The effect of the sphere of positive electrification is merely to produce a field of force directly as the distance from the centre of the sphere. The artificiality of this hypothesis is partly justified by the necessity, in order to meet the facts, of introducing from the beginning some essential difference, other than that of mere sign, between positive and negative. Some of the most interesting of Thomson's results depend essentially upon the finiteness of the number of electrons; but since the experimental evidence requires that in any case the number should be very large, the present author here inquires what becomes of the theory when the number is infinite. The cloud of electrons may then be assimilated to a fluid, whose properties, however, must differ in many respects from those with which we are most familiar. The whole quantities of positive and negative are supposed equal. The difference between them is that the positive is constrained to remain undisplaced, while the negative is free to move. In equilibrium the negative distributes itself with impunity throughout the sphere occupied by the positive, so that the total density is everywhere zero. There is then no force at any point; but if the negative be displaced a force is usually called into existence. The problem of simple vibrations proportional to e^{ipt} is then tested by the hydrodynamical or acoustical method (using velocity potential), in which the fluid is supposed to be incompressible and to move irrotationally. The value of p^2 is thus found to be proportional to $\rho_0 n/(2n+1)$, where ρ_0 is the density of the positive and negative in the atom when in equilibrium, and n the order of the series of harmonics. This partly corresponds to the characteristics of the series of spectrum-lines for hydrogen and the alkali metals. It is also noteworthy that p^2 is independent of the radius of the atom. The more strictly electrical treatment of the problem is then discussed, but is found to lead to expressions which are unacceptable physically for radiation *from* the atom, and therefore with amplitude decreasing with increasing distance. A partial escape from these difficulties might be found in regarding actual spectrum lines as due to *difference tones* arising from primaries of much higher pitch. The hypothesis of the rotation of electrons in orbits is then discussed, but here also difficulties are encountered. For example, how can the atom have the definiteness which the spectroscope demands? [See also Abstract No. 964 (1904).] (Ibid. p. 292, Feb.) Note to above paper. E. H. B.

557. *Retention of an Electric Charge by Gases.* **W. A. D. Rudge.** (Cambridge Phil. Soc., Proc. 13. pp. 194–196, Jan. 31, 1906.)—If the air inside a Leyden jar have its pressure reduced to less than 1 cm., the gas itself may form the internal coating. If one exhausted tube is concentric with another the rarefied gases serve as the coatings and the arrangement constitutes a condenser. R. S. W.

DISCHARGE AND OSCILLATIONS.

558. *Effect of Hydrogen on the Discharge of Electricity from Hot Platinum.* **O. W. Richardson.** (Cambridge Phil. Soc., Proc. 13. pp. 192–193, Jan. 31, 1906.)—The current between two concentric cylinders is measured; the inner of the two is platinum, through which hydrogen diffuses from the interior. The tube is heated and the current measured, first when the gas is diffusing, and secondly when it is not so passing. No alteration is observed in the negative leak. This result points strongly to the conclusion that the increased ionisation observed in an atmosphere of hydrogen by various physicists is not due to the hydrogen in the metal as hydrogen, but to some alteration it produces in the surface region of the metal. On the other hand, the hydrogen increases the positive leak. R. S. W.

559. *Electrical Conductivity of Flames.* **J. F. Davidson.** (Phys. Zeitschr. 7. pp. 108–112, Feb. 15, 1906. From the English.)—This is a preliminary account of an investigation whose object is to determine the influence of the temperature and material of the electrodes on the conduction in flames impregnated with salt vapours. The electrodes are tubes through which cold water constantly flows when necessary; their temperature can thus be kept constant while that of the flame is varied. If the current is first measured with cooled electrodes, and then the water flow stopped and the metal heated to redness, scarcely any difference is found. R. S. W.

560. *Canal Rays.* **J. J. Thomson.** (Cambridge Phil Soc., Proc. 13. pp. 212–214, Jan. 31, 1906.)—The question of ionisation by the impact of positive ions against the molecules of a gas, and the nature of the spectra produced by such impacts, can be conveniently studied by means of canal rays. The author uses a large perforated disc as a kathode, in the centre of which is a hole opening on to a metal tube. The canal rays pass through this tube on their way to strike against a metal plate mounted at an angle to the path of the rays in a special compartment. If this plate is charged negatively to 80 volts, the impact of the canal rays causes a feeble glow to proceed from it, due to the liberation of kathode rays. When the plate is charged positively, there is a deflection of part of the canal-ray beam towards it, showing that the canal rays ionise the gas they traverse. When the canal rays lose some of their velocity they recombine into electrons and become neutral atoms. This critical velocity is of the order 10^8 cm. per sec., but is known to be much higher in the case of the a-rays from radium. When the canal rays impinge upon a salt of sodium the D lines shine out, but not when they impinge upon metallic sodium. The rays disintegrate a metal upon which they impinge. E. E. F.

561. *The Arc in High Vacua.* **R. E. Loving.** (Astrophys. Journ. 22. pp. 285–304, Dec., 1905.)—The author has made a long series of experiments

upon the discharge between terminals placed very close together, *e.g.*, about 1 mm. apart. When the pressure is as low as a few thousandths of a millimetre and an external spark-gap of 2 or 2·5 cm. is used in series, the discharge passes in the form of an arc, and the phosphorescent glow over the walls of the tube disappears. It is found that under these circumstances the kathode particles are shot off only by the surface of the kathode nearest to the anode, and almost all of them strike the opposite face of the anode, causing it to glow strongly; a few of these particles, however, miss the face of the anode, but are attracted in by the strong field, making the hinder portion of the anode glow. The spectrum of the glow on the front of the anode shows only the lines of the metal forming the anode, the kathode metal lines are not shown at all. Both arc and spark lines appear, the relative intensities being somewhat different from those which usually are obtained. The action of a magnetic field was also observed, and it was found to increase the p.d. in the gap, and, consequently, the kinetic energy of the kathode rays.

E. C. C. B.

562. *Properties of Enclosed Arcs.* **W. B. v. Czudnochowski.** (Deutsch. Phys. Gesell., Verh. 7. 24. pp. 465–467, Dec. 30, 1905.)—A short paper mentioning briefly the observations of G. Rosemeyer on enclosed arcs [see Abstract No. 1011 (1902)]. The explosion that often occurs on switching on an "enclosed" arc, which has had time to cool after a previous run, is explained as being due to the formation of an explosive mixture during cooling, by air leaking into the CO previously formed. The gas pressure inside the globe of an enclosed arc depends upon the spring action of the valves. Increasing the tightness of closure lengthens the life of the carbons, enhances the light-efficiency of the lamp, and increases the ratio of the rate of consumption of the positive carbon to that of the negative carbon. The periodic extinctions that occur take place more often the slower the consumption of the carbons.

J. D. C.

563. *Size and Temperature of the Negative Crater of the Electric Arc.* **M. Reich.** (Phys. Zeitschr. 7. pp. 73–89, Feb. 1, 1906. Écl. Électr. 46. pp. 300–303 Feb. 24, and pp. 378–382, March 10, 1906.)—The carbons are at right angles to each other, and so situated that the negative crater is exposed. An optical micrometer is used to determine the diameter, and hence the area of the negative crater. For the determination of its temperature the intensity of radiation of wave-length 0·6563μ is measured by means of a modified Wanner pyrometer [see Abstract No. 467 (1902)], the radiation being compared with that of calibrated glow-lamp by comparing the intensities of the effects on a photographic plate, under similar conditions. Knowing the temperature of the lamp, that of the carbon of the arc may be calculated from Wien's formula, which becomes $\log J/J_1 = -(C_2/\lambda)(1/T - 1/T_1)\log e$, where radiation of constant wave-length is employed. J and J_1 are the intensities of the radiation and T and T_1 the temperatures of the bodies, the assumption being made that these may be considered to present "perfectly black" surfaces up to the temperatures investigated. The apparatus being calibrated, the crater is photographed at successive, very small intervals of time, and the p.d. and current curves photographed simultaneously on the same revolving plate by means of a Duddell oscillograph. The p.d., current, and size of crater are then plotted in the form of curves for various cases. With sudden increases of current the crater does not immediately take up its steady value, and while it is increasing the temperature is above the normal; on the crater acquiring the size corresponding to the new current, the

temperature falls to its original value. A similar lag of size of crater behind current is observed on suddenly decreasing the current. The alternating-current arc could not be observed, owing to the much higher temperature of the carbon when the crater is positive than when it is negative; cases, however, are given in which the alternating current is superimposed on a continuous current. The paper closes with a discussion of the phenomena from the point of view of the ionic theory. When a sudden change in current occurs, the author recognises three phases of the process: in the first, the crater area and temperature have not appreciably increased, so that the emission of ions has not increased, and the p.d. therefore rises; in the second phase the temperature rises, and an increased emission of ions results; in the third phase the crater grows to the normal area for this current, the temperature falls to the constant amount which it acquires for all currents under static conditions, and the p.d. falls to its final value. The slower the changes the more restricted become the first two phases.

S. G. S.

564. *Dielectric Strength of Gases at very High Pressures.* **C. E. Guye** and **H. Guye.** (Phys. Zeitschr. 7. pp. 62–63, Jan. 15, 1906. Paper read before the Liége Congrès de Radiologie. From the French.)—The authors have investigated the spark-potential in the following carefully purified and dried gases: N, O, H, and CO_2. One constant length of gap (0·2 mm.) was employed. Potentials were measured by absolute electrometer with a form of Abraham-Lemoine arrangement, and are given in c.g.s. electrostatic units. The gas pressures (p) were determined by nitrogen manometers, and are expressed in metres of mercury at 0°; the measurements extending from $p=2{\cdot}07$ to $p=65{\cdot}10$ are given in a table in which the limiting value of the spark-potential in the case of N, O, and air is roughly about 60; that of H, 40. The following conclusions are arrived at: Up to nearly 10 atmos. pressure the spark-potential increases linearly with the pressure, thus confirming Wolf's results (Wied. Ann. 37. p. 306, 1889), and also agreeing with those of Ryan [Abstract No. 1633B (1905)]. At higher pressures the ratio *spark-potential / pressure* diminishes, the curves representing the spark-potential as a function of the pressure assuming a parabolic form. In the case of nitrogen, the spark-potential shows a maximum in the neighbourhood of the max. compressibility ($pv_0=$ min.), also noticed to a slight extent with air (at $p=65$ m.). With hydrogen and oxygen the minimum of pv was outside the experimental range, and no max. was observable. The few experiments on CO_2 near the critical temperature appear to point to a reduction of the spark-potential at this stage, but the decomposition of the gas complicates matters. Experiments with a radium salt present or Röntgen rays gave practically the same results.

L. H. W.

565. *Dielectric Strength of Air.* **A. Russell.** (Phil. Mag. 11. pp. 237–276, Feb., 1906. Communicated by the Physical Soc., Nov. 24, 1905.)—It is pointed out that in determining the potential gradient necessary to produce disruptive discharge, from the mean potential gradient between two conductors, care must be taken that there is no glow surrounding the electrode, as in this case there is a displacement of the equipotential surfaces. Further, the disruptive voltage, when using electrodes whose distance apart is less than 0·5 cm. must be reduced by an amount ϵ (the "lost volts") when calculating the electric intensity at the instant of disruptive discharge. The author then gives a historical section, in which

Kirchhoff's calculation of the maximum electric intensity between two spheres, and A. Schuster's tables of the same are mentioned. Then follow sections in which the calculation of the maximal electric intensity in the cases of two concentric spheres and coaxial cylinders is given, and in the case of two equal spheres, is performed by means of series, and the approximate formula given, the limiting distance for which the corona is formed being found. The case of a pair of infinite parallel cylinders is then treated, and the paper closes by quoting the experimental results of Kelvin, A. Heydweiller, J. Algermissen, J. Joubert and G. Carey Foster, É. Hospitalier, and the Compagnie de l'Industrie Électrique with direct voltages, and C. P. Steinmetz, E. Jona, with alternating voltages. It is concluded that the dielectric strength of air at ordinary atmospheric pressure lies between 38 and 39 kilovolts per cm., and is approximately constant. This is slightly higher than the value given by J. J. Thomson (30) [" Electricity and Magnetism," p. 59] and by M. O'Gorman (27) [see Abstract No. 1574 (1901)].

S. G. S.

566. *Intermittent Vacuum Discharges.* **R. Reiger.** (Phys. Zeitschr. 7. pp. 68–69, Jan. 15, 1906. Paper read before the Liége Congrès de Radiologie.) —The periodicity of a vacuum discharge is not necessarily the same throughout the circuit. The author inserted several telephones in different parts of the vacuum-tube circuit, and found that the rhythm of discharge may be very different in the tube and the leads. In constricted tubes, one part of the tube itself has a different rhythm from another part. If a condenser is mounted in parallel with a constricted part, by means of incandescent probes, the rhythm in the constricted part is retarded.

E. E. F.

567. *Gaseous Electric Valve.* **A. Wehnelt.** (Ann. d. Physik, 19. 1. pp. 138–156, Jan. 18, 1906. Écl. Électr. 46. pp. 260–264, Feb. 17, 1906.)—The valve is based upon the action of the oxides of barium, strontium, and calcium in facilitating the projection of electrons from incandescent kathodes, and thereby reducing the kathode-fall to vanishing-point. It consists of a spherical globe, in the centre of which is mounted a kathode of Pt-foil 0·003 cm. thick and having an area of 8 sq. cm. It is covered with a layer of one or more of the oxides, and heated by a current of 10 amps. conveyed by platinum wires soldered into platinum tubes, which in turn are inserted in the glass. This arrangement prevents the glass being cracked by the heating. Three anodes of stout copper wire surround the kathode. For currents ranging from 0·1 amp. to 20 amps. the discharge potential is quite constant, and amounts to 19 volts. With alternating currents the valve action is perfect, only one wave of the current being transmitted. To transmit the current in the other direction and force electrons out of the anodes would require several thousand volts. The valve action is the same at all frequencies, even in the case of Lecher and Tesla currents. It is possible to obtain both waves in the same direction, and thus also to detect oscillations with the galvanometer [compare Abstract No. 807 (1905)].

E. E. F.

568. *Duration of Discharge in a Vacuum Tube.* **A. Broca.** (Comptes Rendus, 142. pp. 271–273, Jan. 29, 1906.)—The tube under investigation was put in series with a Villard turbine-interrupter, and excited by means of an induction coil. Under these conditions only a disruptive discharge passed in the circuit. The mean intensity of the current traversing the tube was

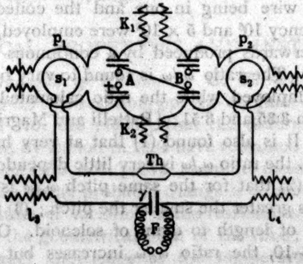
measured by a d'Arsonval and Gaiffe milliammeter. The number of interruptions per sec. was obtained by a stroboscopic method. Turchini [see Abstract No. 1215 (1905)] has shown that a Röntgen-ray tube reaches, from a 10-cm. equivalent spark upwards, a state where the strength of the Röntgen rays which emanate from it, for a constant mean intensity, is independent of the length of the equivalent spark. The results described in this paper prove that this constancy of the exterior effects due to the Röntgen rays is intimately connected with an analogous constancy of the interior conditions relating to the kathode discharge. It is probable that it is only for a spark equivalent of 10 cm. that the pure kathode phenomenon is produced. Beyond this the tube seems to be characterised by a well-defined condition of discharge. It appears that the Röntgen-ray tube resists the passage of the current up to a certain value of the potential depending on the degree of exhaustion, and that then it exhibits a disruptive phenomenon which starts the eddying of the kathode afflux and of the kathode rays. This eddying seems to have a period of its own, nearly independent of the degree of exhaustion beyond the point where the pure kathode discharge occurs. The discharge in the case of the tube employed took place in 0·0005 sec. whether connected to a large coil or to a small coil having a much higher natural period of its own. A. W.

569. *Resonance in Wireless Telegraph Circuits.* III. **G. W. Pierce.** (Phys. Rev. 21. pp. 367–380, Dec., 1905. Écl. Électr. 46. pp. 193–197, Feb. 3, 1906.) Continuing his experiments [see Abstract No. 1274 (1905), and Écl. Électr. 43. pp. 429–440, 1905], still using inductively coupled circuits at transmitter and receiver, and the high-frequency dynamometer, the author investigates the effect of varying the coefficient of coupling (k). M. Wien, from theoretical considerations, has shown that when k (here called τ) is large the greatest distant effect should be obtained; but the resonance will not be sharp. When k is small, on the other hand, the resonance will be sharp but the distant effect should be much reduced. The mutual inductance at the transmitter being left constant, the effect of making k at the receiver successively 0·30, 0·213, 0·141, 0·071 is examined. The tables and curves should be referred to. It is found that the relation between height of antenna and resonant capacity with variation of k agrees with but slight departure with that demanded by theory. Using the length of receiving antenna (24 m.) which gave the best results with the 16-m. transmitter wire, the effect of varying k is shown by the values of the maxima at the receiver for the above four values of k: 64, 31·5, 9·5, 3. When the antenna is long the deflections are roughly proportional to k^2, as would be expected; with shorter lengths the ratio of the deflections varies in a complex manner. As regards sharpness of resonance, with the dynamometer employed, of resistance only 1·33 ohms, the deflection falls to half for a change of capacity of 5 per cent. when $k = 0{\cdot}30$; with $k = 0{\cdot}071$ the fall to half takes place for a change of capacity of 2½ per cent. Since the deflection $\propto$ energy, and capacity $\propto$ $(\text{period})^2$, the energy falls to half for a dissonance of 2·5 and 1·5 per cent. in the two cases respectively. But with constant transmitter, to double the sharpness of resonance, k has to be changed at the receiver to such an extent that the energy received is only 1/20th. With a higher resistance receiver the resonance would not be so sharp and the effect of diminishing k would be less. L. H. W.

570. *Radiation at Resonators in Regions of Short Electric Waves.* **M. Paetzold.** (Ann. d. Physik, 19. 1. pp. 116–137, Jan. 18, 1906. Extract from

Dissertation, Leipzig, 1905.)—The experiments here described lead to the following results. (1) To generate intense and but slightly damped waves an inductive oscillator is desirable if the experiments permit a screening-off of the disturbing waves from the primary itself. (2) The behaviour of resonator systems in the radiation field of an oscillator is dependent on the distance apart of the separate elements (of the resonator system). If this distance is of the order of a half wave-length, then the period of the separate resonators is not altered. But if this distance is reduced, then their period appears to be thereby changed. If the distance apart is made within 1 or 2 per cent. of the whole wave-length, then the resonance curve shows a flattening of its sharp maximum, but no shift of that maximum is perceptible. (3) The experiments of Aschkinass and Schäfer, and probably those of Garbasso, according to these experiments and the ordinary theoretical views, may be explained, not according to their authors as absorption-phenomena, but rather their results may be taken as due to the incident radiation and that sent out from the grating resonators. [See also Planck, Abstract No. 1078 (1903), and Kirchner, No. 744 (1904).] E. H. B.

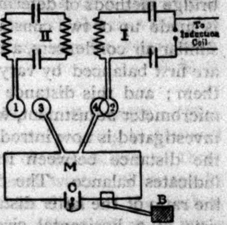
571. *High-frequency Oscillations.* **F. Braun.** (Electrician, 56. pp. 546–549, Jan. 19, 1906. Écl. Électr. 46. pp. 311–315, Feb. 24, 1906.)—A continuation of the author's researches on phase-shifted oscillations [see Abstract No. 1151B (1904)]. The object was the study of the currents in two coupled circuits when there was a difference of phase between them, the end to be obtained being a field distributed unequally round a transmitting station for the purpose of giving direction to the signals. The principal circuits are coupled loosely to two secondary coils connected in series through a hot-wire air-thermometer ammeter. The secondaries may be connected either so as to give the sum of their effects, or in opposition to give their difference. The phase-difference is given by $\tan(\phi/2) = \sqrt{T_2/T_1}$ if T_1 and T_2 be the thermometer readings in the two cases, or $\tan(\phi/2) = f_2/f_1$ if the measurements be made by a comparison of sparking-distances f_1 and f_2 instead of by the hot-wire thermometer. In Fig. 1, s_1 is excited by p_1, and s_2 by p_2. The "measuring" circuit is tuned by means of the condenser γ and the self-inductions l_3 and l_4, which serve at the same time to weaken the coupling. The measurements are made either with the thermometer Th or a spark-gap F connected in parallel with the condenser. In spite of difficulties mentioned, the method can supply qualitative indications at any rate. It has been found that quite a number of results obtained by these methods with oscillations of frequency above 10^6 were verified in connection with oscillations of lower frequency (about 10^4), which were investigated by



means of the Braun tube. To produce phase displacement by means of ohmic resistance involves a great loss of energy, and is therefore of little practical use. Acoustic resonance, however, indicates a method of obtaining the desired result. If the natural frequency be higher than the impressed frequency, the phase-difference lies between 0 and $\pi/2$; when they are equal, the value is $\pi/2$; and when the natural frequency is the lower, the phase-difference ranges between $\pi/2$ and π. Electrically the conditions are somewhat more complex. If two equi-frequent circuits be coupled, two new frequencies appear in the circuits, which become dephased if the damping, or radiation, of the circuits is different. Taking no account of damping, however, the compound oscillation in the first circuit, considered as one oscillation, is out of phase with that in the second, the phase-difference being practically constant. Proof of this was obtained by the Braun tube, the two coils of which were connected one to each of the circuits under examination, and placed so as to act on the ray in directions at right angles to one another. A difference of phase between the currents causes the ray to describe a series of elliptical figures observed on the screen. The apparatus can be used for studying oscillations of frequencies up to at least 10,000 per sec. Results are given showing the effects of the introduction of self-induction and ohmic resistance into the circuits. J. E.-M.

572. *Resistance of Coiled Wires for Electrical Oscillations.* **T. P. Black.** (Ann. d. Physik, 19. 1. pp. 157–168, Jan. 18, 1906. Extract from Strassburg Dissertation.)—The author describes experiments made to determine the quantitative relation between the effective resistance (ω) of a straight wire and that (ω_s) of the same length of wire when coiled up so as to form solenoids of different length, diam., and turns per unit length (= 1/pitch), using wires of different diam. Two air thermometers were used as calorimeters, as in one of Battelli and Magri's experiments [see Abstract No. 355 (1904)], the straight wire being in one and the coiled wire in the other. Oscillations of frequency 10^6 and 5×10^6 were employed, the same rise in the capillaries being afterwards produced by a continuous current, whence the ratio ω_s/ω is deduced. The ratio ω_s/ω is found to vary between 1·20 and 1·89 with the solenoids employed, while the ratio calculated from Sommerfeld's theory varies between 3·35 and 3·51. [Battelli and Magri gave for ω_s/ω values from 1·79 to 2·17.] It is also found (1) that at very high frequencies and with large wire diam. the ratio ω_s/ω is very little dependent on the frequency and the coil diam.; (2) that for the same pitch ω_s/ω is greater the greater the wire diam., and is greater the smaller the pitch; (3) that it is also greater the greater the ratio of length to diam. of solenoid. Once this latter ratio reaches the value 6–10, the ratio ω_s/ω increases but little, the solenoids behaving practically like infinitely long solenoids. The qualitative correspondence with Sommerfeld's theoretical results is then dealt with, and it is pointed out that the correcting factor for bringing Sommerfeld's results into agreement with actual values appears to depend solely on the ratio *pitch/radius of wire*, which also applies in the case of coils of few turns of large diam. (30 cm.), as used in wireless telegraphy, experiments with which are described at the end. Even with these coils, with the same frequency and coil diam., the ratio ω_s/ω increases (1) with the number of turns for the same size wire and same pitch; (2) with decrease in pitch with the same size wire, or with increase of diam. of wire when the pitch is constant. The absolute value of the resistance found at a frequency of 10^6 per sec. ranges from 1·18 to 1·47 times the resistance of the wire when straight. L. H. W.

573. *Method of separately examining the Two Waves in Coupled Oscillators.* **C. Fischer.** (Ann. d. Physik, 19. 1. pp. 182–190, Jan. 18, 1906. Phys. Inst., Strassburg. Écl. Électr. 46. pp. 354–356, March 3, 1906.)—The author points out that while the two waves in coupled systems can be separately examined by Bjerknes' method if the coupling is close or moderately close, *i.e.*, when the resonance curve drops to zero between the resonance peaks, this is not the case when the coupling is loose, *i.e.*, when the difference between the frequencies is very small, in which case the two peaks nearly overlap. A method suggested by Zenneck is described which enables each wave to be examined separately by Bjerknes' method. The arrangement employed in the Fig. is adopted. The circuits I, II are horizontal, and only the loops 1, 2, 3, 4 vertical. If 1 and 2 are placed about 1 m. apart and 4 is coupled with 2, with 3 in any position, two waves will be present as a rule in the measuring circuit M. When this latter is brought into resonance (by altering C) with one wave, on bringing 3 nearer to 1 a minimum reading on the galvanometer can be obtained, any further approach giving an increased deflection. With 3 in this position the resonance curve shows only one maximum, that of the other wave; which of the two waves it is found by experiment. To obtain the second wave the connections of the loop 1 need only be reversed and 3 shifted slightly. A practical example is given. The values of k (the coefficient of coupling) [see Fleming, Abstract No. 2246 (1905)] calculated in the first case from the observed values for $n_1^2(1-k)$, and in the second case from $n_2^2(1+k)$, are as follows: (I) 0·026, 0·069, 0·389; (II) 0·031, 0·070, 0·389. The theory does not thus agree well with experimental results in the case of loose coupling. L. H. W.



ELECTRICAL PROPERTIES AND INSTRUMENTS.

574. *Mercury Standards of Resistance.* **C. E. Guillaume.** (Soc. Int. Élect., Bull. 6. pp. 7–19; Discussion, pp. 19–21, Jan., 1906.)—Girousse has shown [see Abstract No. 370 (1906)] that the differences of the mercury standards constructed by Benoit in 1884 have remained remarkably constant, but the measurements do not prove absolute constancy of any of the standards. Some idea of the probable change is obtained by a consideration of the three main causes of variation in the resistances as computed. These are: (1) change in the geometrical form of the tube; (2) impurities in the mercury; (3) incorrect knowledge of the temperature coefficient of the standards. In order to obtain an estimate of the magnitude of (1), some particulars are given of *verre dur* thermometers belonging to the International Bureau of Weights and Measures. In 20 years the change in zero has been about 0·05° C., and probably the capacity of a thermometer bulb changes more than the capacity of a mercury standard; hence it is concluded that the latter will not change more than 25 parts in 10,000,000 in 20 years (excluding the change in the first year). Impurities of the mercury are most serious, and every precaution must be taken to ensure the liquid being quite pure. With regard to (3), three determinations of the temperature coefficient of resistance of mercury have been made. The first was by the author in 1890; the second by Kreichgauer and Jäger at the Physikalisch-Technische Reichsanstalt in 1892, and the third by Smith at the National Physical

Laboratory in 1903. The author points out that the results of Kreichgauer and Jäger are better represented by a formula containing a second term larger than the one given by them, and the formula is modified accordingly. The result is that the three determinations become practically identical. In the *discussion*, **P. Janet** gives some particulars of the electrical measurements. F. E. S.

575. *Dielectric Constants of Liquids.* **V. H. Veley.** (Phil. Mag. 11. pp. 73–81, Jan., 1906.)—The author describes a modification of the usual bridge methods of determining the dielectric constants of liquids. A bridge is made up of two constant liquid resistances, two specially constructed and similar air condensers, a telephone, and an induction coil. The condensers are first balanced by varying the distance between the electrodes of one of them; and this distance is carefully measured by a suitable and accurate micrometer adjustment, which moves the upper electrode. The liquid to be investigated is now introduced by means of a pipette into this condenser, and the distance between its electrodes again adjusted until the telephone indicates balance. The dielectric coefficient of the liquid is calculated as the ratio of the latter distance to the former. The movable electrode consists of a horizontal circular disc of gilded nickel, which can be moved along the vertical axis of a cylindrical dish, also of gilded nickel, with vertical sides and a horizontal circular bottom, which latter contributes the major portion of the capacity. The errors due to the edge effect of movable electrode and to its stem were found to be of the second order and therefore negligible, the measurement being accurate only to the degree of 1 per cent. A description and illustration of the condenser are given, together with some dielectric coefficients obtained by its use. J. D. C.

576. *Electrolytic Mercurous Sulphate for Standard Cells.* **G. A. Hulett.** (Phys. Rev. 22. pp. 47–51, Jan., 1906. Abstract of paper read before the Amer. Phys. Soc., Oct. 28, 1905.)—The author gives further particulars of some standard cells constructed in 1903 [see Abstract No. 1932 (1905)], the depolariser of these cells being electrolytic mercurous sulphate. The variations in e.m.f. of single cadmium cells are not more than 2 parts in 100,000, but the Clark cells are not so constant, as they show variations of about 5 parts in 100,000, disregarding the temporary variations due to the generation of gas at the zinc amalgam. Guthe, of the Bureau of Standards, has redetermined the absolute value of the cadmium cell with a newly constructed electrodynamometer, and the author is informed that the new cadmium cells have an e.m.f. of 1·01836 absolute volts at 25° C., and cadmium cells made in the old way have an e.m.f. of 1·01864 volts at the same temperature. An attempt was made to simplify the construction of standard cells by forming the depolariser in the cell after it had been set up, but such cells never showed a constant value. F. E. S.

577. *Constant of Absolute Electrodynamometer.* **G. Lippmann.** (Comptes Rendus, 142. pp. 69–71, Jan. 8, 1906. Ind. Élect. 15. pp. 41–43, Jan. 25, 1906.) —This paper describes an induction method of determining the constant of an electrodynamometer. In an absolute instrument many layers of wire and a light movable coil are requisite for sensitiveness, but one layer only is preferable if an accurate computation of the constant is desired. The author suggests a method of overcoming this difficulty by comparing the mutual inductance P of the two coils with that of a well-constructed standard, P

being observed for several angles of inclination of the suspended coil. If an interrupted current (n interruptions per sec.) passes through the inducing coil of the standard the total quantity of electricity induced in the secondary at break is $n\mathrm{LI}/\mathrm{R}$, where R is the resistance of the secondary circuit, I the maximum current strength, and L the mutual inductance. If at the same time the interrupted current passes through the fixed coil of the electrodynamometer, the total quantity of electricity induced similarly is $n\mathrm{PI}/\mathrm{R}'$, where R′ is the resistance of the secondary circuit. The two quantities thus induced may be made equal by an adjustment of the resistances, and the equality may be detected by including the two bobbins of a differential galvanometer in the circuit. By making observations with the movable coil of the electrodynamometer inclined at an angle, $d\mathrm{P}/dx$ may be determined, x being the displacement. F. E. S.

578. *Thermoelectric Circuit of Three Metals.* **H. E. Schmitz.** (Phil. Mag. 10. pp. 631–642, Dec., 1905.)—The full paper corresponding to Abstract No. 1771 (1905). The e.m.f.'s in microvolts of pairs of metals and of three metals are given in tables, for soft wires and hard wires. The results obtained by other experimenters are compared with those of the author. The values given by Noll and by Maclean for "undrawn" and "drawn" wires are made use of, Maclean's "annealed steel" being taken as the equivalent of iron [see Abstract No. 1858 (1900)].

EXCESS OF "HARD" OVER "SOFT" WIRES.

	NOLL.	MACLEAN.	SCHMITZ.
Copper-Iron..................	+ 2 per cent.	— 1 per cent.	— 4½ per cent.
German Silver-Copper ...	+ 2 „	+ 3 „	+ 5½ „
„ „ -Iron	+ 2 „	+ ½ „	+ ½ „

L. H. W.

579. *Microphonic Contacts for Relays.* **C. Jensen** and **H. Sieveking.** (Ann. d. Physik, 18. 4. pp. 695–724, Dec. 12, 1905. Phys. Staatslaborat. Hamburg u. Phys. Inst. d. techn. Hochschule, Karlsruhe.)—Experiments are described, made with a relay with carbon contacts somewhat similar to Edison's carbon-contact relay, for the purpose of ascertaining their suitability for telegraphic purposes and for indicating weak currents. The results are given in tables and curves, which should be referred to. No definite conclusions are arrived at beyond that currents of 1/50 milliamp. will give definite, and of 1/25 milliamp. excellent results for a considerable time, after which the contacts require seeing to. The effect of pressure and the value of the current on the contact resistance was also examined, and the effect of very small applied e.m.f.'s (1/50000 to 1/15000 volt) noted. It is found that even with the lowest e.m.f. (current of order 10^{-7} amp.) the resistance of the contact diminishes; the final reading is only reached after some time—the longer, the smaller the current through the contact. L. H. W.

580. *Portable Gold-leaf Electrometer.* **C. T. R. Wilson.** (Cambridge Phil. Soc., Proc. 13. pp. 184–189, Jan. 31, 1906.)—The gold-leaf is found in the inner of two concentric brass tubes, but is insulated therefrom. The outer tube is earthed; the inner is kept charged to a constant potential by being connected to a small Leyden jar. This jar is made by silvering the interior face of a small quartz flask, and covering the outer face with tin-foil. A device, consisting of a small adjustable condenser, enables the user to charge the leaf up to the same potential, about 100 volts, repeatedly, when once the charge on the Leyden jar has been properly adjusted. The leaf is observed by a microscope; the double tubing surrounding it screens it so effectually from convection currents that it may be used in the open air. R. S. W.

ALTERNATING CURRENTS AND MAGNETISM.

581. *Magnetic Observations during Solar Eclipse.* **P. Cirera.** (Comptes Rendus, 141. pp. 1270–1271, Dec. 26, 1905.)—Special attention was devoted to the observation of the magnetic elements during the total solar eclipse of Aug. 30, 1905, at the Observatory de L'Ebro, Tortosa, Spain. The instruments were installed in a constant temperature room; for the declination scale 1 mm. was equal to 1′ of arc, and to 0·00005 c.g.s. for the two components of the force. All the photographic curves show that Aug. 29, 30, and 31 were days of magnetic disturbance, indicating a diminution of the westerly declination, and of the daily amplitude. Preceding the eclipse the amplitude was 12′·2, during the eclipse 8′·5 and after, 11′·8. Duplicate observations were made at Alcosebre and Palma, and from a comparison of these some notable facts are derived. In the mean of the curves from Aug. 14 to Sept. 15 there was an augmentation of 2′·4 from 11 a.m. to 1 p.m. On the day of eclipse this quantity was 0′·7 at Tortosa and Palma, and only 0′·1 at Alcosebre. Now the latter station was very much nearer the central line of eclipse than the others, and it appears that this may account for the difference of effects. In the horizontal force the usual rise to maximum between 1 and 2 p.m. was arrested, the highest value scarcely exceeding the mean for the day. The usual minimum value of the vertical force occurred a little before midday, but during the eclipse the value augmented, and the mean value for the day was attained about 2h., just after the eclipse. In examining the curve of earth currents, it was noticed that while before and after the eclipse there were continually small oscillations, there was relative calm during totality and the time of greatest obscurity. *At Sfax, Tunis.* **Dehalu.** (Ibid. 142. pp. 186–187, Jan. 15, 1906.) C. P. B.

582. *Effect of Oscillating Field on Magnetic Hysteresis.* **F. Piola.** (Elettricista, Rome, 5. pp. 4–6, Jan. 1, 1906.)—In a previous paper the author has advanced the opinion, which is contrary to that of several experimenters, that a rapidly oscillating magnetic field superimposed upon the primary alternating field causes an increase in the hysteresis effect exhibited by the specimen [see Abstract No. 829 (1905)]. In order to avoid the effects of inertia of the moving parts, the magnetometer is replaced by the Braun's tube. One coil, carrying an alternating current, gives a displacement of the fluorescent spot proportional to the magnetising field, while two others at right angles to, and in series with the first, surround the specimen, which thus gives a displacement proportional to its intensity of magnetisation, the direct magnetic effect of the coils being eliminated by means of compensating coils. With alternating current only, the usual hysteresis curve is obtained, but this is considerably modified when a rapidly reversed current is sent through one of the coils so that its magnetic effect upon the specimen is superimposed upon that of the alternating current, the two fields having the same direction. When the amplitudes of the primitive and superimposed cycles are nearly the same, the effect of the latter is to produce a considerable increase in the area of the cycle; the curve becomes straightened and approaches the axis of ordinates, indicating an increase in permeability. When, however, the amplitude of the primary cycle is much greater than that of the superimposed, the curve appears broken, the pieces being rotated inwards, just as would be produced by superimposing small cycles upon a larger one; the outline of the primary remains faintly and undisturbed in position. With dimensions intermediate between these two, interlacing lines appear which follow a curve which is the median of the primitive cycle, the limits of which are further from the axis of abscissæ than in the case of the primitive, thus indicating an increase in permeability. From the manner of formation of the curve in this case the author concludes that there is no real diminution in hysteresis. [See also Abstract No. 2977 (1904).] S. G. S.

583. *Magnetic Fields of Currents in Conducting Sheets, and Disturbance of Compass by Currents in Hull of Ship.* **C. Arldt.** (Elektrotechn. Zeitschr. 27. pp. 70–77, Jan. 25; and pp. 91–95, Feb. 1, 1906.)—This paper contains an elaborate mathematical and experimental investigation of the magnetic effects due to currents flowing in thin sheets of conducting material, and of the possible deviations of the compass due to currents flowing along the iron hull of a ship. A brief summary is first given of the earlier work on two-dimensional problems in current flow. The author then shows that so far as the magnetic effect at a given point is concerned, the conducting sheet may be replaced by a linear conductor conveying the same total current and placed at a definite distance u from the point. If the point lies symmetrically above or below a plane sheet and at a distance k from it, the plane containing the point and the middle line of the conducting sheet being normal to this sheet, then the distance u of the equivalent linear conductor exceeds k. If, on the other hand, the point lies in the plane of the conducting sheet at a distance k from its middle line, the distance u of the equivalent linear conductor is less than k. It is next shown that the currents which may arise in the hull of a ship are capable of producing serious disturbances of the compass. For this reason, the single-wire system of wiring should not be tolerated. But even with a two-wire system there is no security, as accidental earths on the wires may cause appreciable currents to circulate in the hull. Absolute safety in this respect is only attainable by the adoption of an alternate-current system. A. H.

REFERENCES.

584. *Equilibrium of Fluids in an Electromagnetic Field.* **S. Sano.** (Physico-Mathematical Soc., Tokyo, Proc. 2. 24. pp. 365–380, 1905.)—A highly analytical paper treating the problem of the equilibrium of a heterogeneous fluid in an electromagnetic field. The discussion of stability and the effect of capillarity are not entered upon in the present note. [See also Abstract No. 1054 (1905).] E. H. B.

585. *Phenomenon at a Semi-conducting Film.* **H. Greinacher.** (Ann. d. Physik, 18. 5. pp. 1020–1030, Dec. 28, 1905.)—A continuation of the work dealt with in a former paper [see Abstracts Nos. 1641 and 2094 (1905)]. On charging the gas cells from a 110-volt source, the metals showed a p.d. up to 60 volts. It appeared probable that the cause of this lay in a thin film of P_2O_5 which had sublimed on the metal. E. H. B.

586. *Electrical Vibrations in Ring-formed Tubes.* **A. Kalähne.** (Ann. d. Physik, 19. 1. pp. 80–115, Jan. 18, 1906. Phys. Inst. d. Univ., Heidelberg, Dec. 2, 1905. Écl. Électr. 46. pp. 287–296, Feb. 24; 324–333, March 3; 361–369, March 10; and pp. 408–414, March 17, 1906.—The second part of a highly analytical treatment of these vibrations on Maxwell's theory [see Abstract No. 2247 (1905)]. When damping is eliminated, by the supposition of perfect conductivity of the material of the tubes, expressions are obtained for the electric and magnetic vectors, and also a transcendental equation whose roots give the periods of the series of vibrations possible under the circumstances. E. H. B.

587. *Detector for Small Alternating Currents and for Oscillations.* **L. W. Austin.** (Bureau of Standards, Bull. 1. 3. pp. 435–438, Nov., 1905.)—In the description of the author's rectifying cell given in Abstract No. 162 (1906), the words (lines 7 and 8) "these are polarised," &c. (to end of sentence), should be omitted.

588. *The High-pressure Electric Condenser.* **R. A. Fessenden.** (Electrician, 56. pp. 112–113, Nov. 3, 1905.)—In this letter the writer, in reply to a request from F. Jervis-Smith (Ibid. 55. p. 912, Sept. 22) for information respecting the use of spark-gaps in compressed gases, gives information regarding his own experimental results, chiefly as regards the use of compressed air as dielectric in condensers, most of which have been disclosed in various patents. [No reference is made to the work of M. Wolf (Wied. Ann. 37. p. 306, 1889), who used a spark-gap identical with that devised by the writer in 1901.] L. H. W.

589. *Electric Currents in a Network.* **I. Révilliod.** (Comptes Rendus, 142. pp. 151–153, Jan. 15, 1906.)—The theorem is proved that in any closed conducting network the excess of twice the activity of the batteries over the rate of generation of heat is greater if the currents are distributed in accordance with Ohm's law than if, while obeying the law of continuity, they are distributed otherwise. [This is equivalent to a theorem stated without proof by J. J. Thomson, that $F - 2\Sigma . EC$ is a minimum, F being the dissipation function; but this minimum being a negative magnitude, Révilliod's form of the theorem seems the better.] R. E. B.

590. *Peltier Effect.* **E. Lecher.** (Phys. Zeitschr. 7. pp. 34–35, Jan. 15, 1906.)—The author further justifies his use of a single diagram to represent the Seebeck, Peltier, and Thomson effects in metals [see Abstract No. 155 (1906)]. He shows that the zero-point of the Peltier-effect and the maximum e.m.f. coincide. Any other assumption leads to contradictions. E. E. F.

591. *Magnetic Detectors of Electric Waves.* **L. H. Walter.** Part I. (Technics, No. 20. pp. 127–131, Aug., 1905.) Part II. (Elect. Mag. 4. pp. 359–362, Dec., 1905.)—Brief descriptions, mostly with illustrations, of the different detectors of this class, with notes on the theory of their action. It is pointed out that what is at present uncertain in the theory of these instruments is the cause of the diminution of hysteresis loss observed in stronger fields [see Abstracts Nos. 857 (1904) and 1048, 1290 (1905)].

592. *Eschenhagen-Tesdorpf Magnetometer-Theodolite.* **K. Haussmann.** (Zeitschr. Instrumentenk. 26. pp. 2–15, Jan., 1906.)—Illustrated description.

593. *Small-size Chord-galvanometer.* **M. Edelmann, Jr.** (Phys. Zeitschr. 7. pp. 115–122, Feb. 15, 1906.)—A full description of a portable form of the instrument [see Abstract No. 2261 (1905)]. The weight is only 2·25 kg. With a quartz fibre the sensibility is such as to give a 1-mm. deflection (magnification 128) with 8×10^{-10} amp., or about 10^{-5} amp. with a silver thread. A specially devised photographic recording attachment is also described. Various records of periodic currents are reproduced. L. H. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

594. *Separation of Air into Pure Oxygen and Nitrogen.* **G. Claude.** (Comptes Rendus, 141. pp. 762–764, Nov. 13, and pp. 823–826, Nov. 20, 1905. Journ. de Physique, 5. pp. 5–24, Jan., 1906.)—By the apparatus formerly used [see Abstracts Nos. 404 and 1201 (1904)], compressed and cooled air is led into long tubes surrounded by evaporating liquid oxygen; in its ascent it is partially liquefied, and the liquid thus formed falls and energetically robs the rising air of its oxygen, the gas issuing from the top of the tubes being nearly pure nitrogen, and this is liquefied by passage down another set of tubes in the oxygen bath. The first liquid is then led to the middle of a rectifying column and partially rectifies the ascending gas; the second liquid is led to the top of the rectifying column and completes the rectification of the ascending gas, which issues as practically pure nitrogen. R. E. B.

595. *Microscopic Method of Determining Molecular Weights of High Boiling Solvents.* **G. Barger** and **A. J. Ewins.** (Chem. Soc., Journ. 87. pp. 1756–1763, Dec., 1905.)—The application to less volatile solvents of Barger's method of determining molecular weights [see Abstract No. 2743 (1904)] is rendered possible by the use of a hot stage under the microscope, consisting of a glass tube through which hot water circulates, and in which the capillary tubes are placed. Several capillaries, in each of which the solution under investigation is to be compared with a different standard solution, are placed together in position in this tube, and when the temperature becomes constant at the desired point a first reading of the lengths of the drops in the capillaries is made, and after a brief interval a second reading is taken. Determinations with volatile solvents, such as alcohol, benzene, and acetic acid, may thus be made much more rapidly than at ordinary temperatures, and the method can also be applied to such solvents as pyridine and aniline, with which at ordinary temperatures no results could be obtained. W. H. St.

596. *New Form of Resistance Vessel for Determination of Conductivity of Liquids.* **A. Magnus.** (Deutsch. Phys. Gesell., Verh. 8. 1. pp. 1–8, Jan. 15, 1906. From the Inst. f. physikal. Chemie d. Univ., Berlin.)—The author describes a new kind of resistance vessel for the determination of the conductivity of liquids, and claims for it the following advantages: (1) It can be taken to pieces, cleaned, dried, and filled with liquid without the resistance capacity being altered. (2) The resistance capacity can be varied at will. (3) The apparatus is not easily broken; only the electrodes have to be protected. (4) As long as the level of the liquid is not less than a certain height above the surface of the electrode, the capacity of the vessel is constant. This height can easily be determined; it varies for different apparatus. (5) The conductivities of liquids which conduct as well as sulphuric acid of maximum conductivity, as also the conductivities of the dilutest solutions, can be measured with accuracy. (6) The apparatus is simple and not costly. The only drawback is that a fairly large volume of solution is required. T. S. P.

597. *Novel Mode of preparing Pure Barium.* **Guntz.** (Comptes Rendus, 141. pp. 1240–1241, Dec. 26, 1905.)—The distillation of barium amalgam [see

Abstract No. 617 (1905)] does not yield a metal of more than 98·5 per cent. Ba, but the dissociation of the hydride gives a pure metal free of hydrogen. The amalgam is heated in a vacuum and hydrogen then introduced, the temperature being kept above 900° C. for several hours; at 1,200° C. the barium hydride begins to melt in its iron boat. This hydride is then distilled in another vacuum vessel; when all the hydrogen has been given off, the barium evaporates and is condensed on a cooled polished steel tube in crystals of silver colour and density 3·78, containing 99·56 per cent. Ba. It is noteworthy that the barium hydride has a higher density, 4·21; the same holds for the lithium hydride and metal. The author and Roederer have also prepared strontium by this method. H. B.

598. *Distillation of Osmium, Ruthenium, Platinum, Palladium, Iridium, and Rhodium.* **H. Moissan.** (Comptes Rendus, 142. pp. 189–195, Jan. 22, 1906.)—All the metals of this group have now been distilled, employing the electric furnace devised by the author, and a current varying from 500 to 700 amps. at 110 volts. Osmium distils with the most difficulty, and palladium, which melts more readily than Pt, does not appear to be more volatile than either Pt or Rh. Each of the liquefied metals dissolves carbon, depositing it on cooling in the form of graphite. [See also Abstract No. 401 (1906).] W. H. Si.

599. *Thorium Silicide.* **O. Hönigschmid.** (Comptes Rendus, 142. pp. 157–159, Jan. 15, 1906.)—By heating in an electric furnace a mixture of silicon, thorium, and aluminium, or of the double potassium thorium fluoride with potassium fluosilicate and aluminium, contained in an earthen crucible, a silicide of thorium has been obtained, agreeing in composition with the formula $ThSi_2$. It crystallises in quadratic laminæ resembling pure graphite in appearance, and has a density at 16° of 7·96. W. H. Si.

600. *Alloy of Thorium and Aluminium.* **O. Hönigschmid.** (Comptes Rendus, 142. pp. 280–281, Jan. 29, 1906.)—The production of thorium silicide in the electrical furnace in the presence of Al [see preceding Abstract] is shown to be accompanied by the formation of a compound of Th and Al which crystallises in elongated hexagonal prisms, and has a composition corresponding to the formula $ThAl_3$. The alloy may also be produced by direct combination of the metals *in vacuo* at a high temperature, or by reduction of the double thorium potassium fluoride or of thorium oxide by Al. W. H. Si.

601. *Conductivity and Viscosity of Solutions of Salts in Mixtures of Acetone, Alcohol, and Water.* **H. C. Jones** and **E. C. Bingham.** (Amer. Chem. Journ. 34. pp. 481–554, Dec., 1905.)—Fluidity measurements made with binary mixtures of the solvents revealed a simple additive law for mixtures of acetone with methyl or ethyl alcohol; it is pointed out that this necessitates a hyperbolic relationship when viscosities (1/fluidity) are considered, and that the use of fluidities is to be preferred, not only because it gives simpler results, but also on theoretical grounds. When mixed with water, most organic solvents exhibit a contraction in volume and a very large increase in viscosity, usually attributed to the formation of molecular aggregates (hydrates). Conductivity measurements were made in the case of solutions of lithium nitrate, calcium nitrate, and potassium iodide in binary mixtures of the above solvents. The temperature coefficients of conductivity were in most cases considerably

smaller than the coefficients of fluidity—a result that might in part be attributed to decreasing ionisation. In considering the influence of the composition of the solvent mixture on its own fluidity and on the conductivity produced by salts dissolved in it, a close general relationship was observed in the case of solutions of potassium iodide, which has a high coefficient of ionisation even in the organic solvents; if, therefore, there is any change in the coefficient of ionisation as the solvent is changed, this effect is neutralised and masked by a counterbalancing change in the size of the ionic complexes. Calcium and lithium nitrates, on the other hand, when dissolved in mixtures of acetone and alcohol, show very pronounced maxima of conductivity at an intermediate concentration; since the fluidity curves are straight lines, this change cannot be attributed either to abnormal fluidity or to any sudden increase in the complexity or ionising power of the solvent; if neither of these factors exhibits a maximum, the maximum conductivity can only be attributed to changes in the magnitude of the ion, *i.e.*, to a minimum complexity of the ion at intermediate concentrations of acetone and alcohol.

T. M. L.

602. *Electrical Conductivities of Salt Solutions in Acetamide.* **J. W. Walker** and **F. M. G. Johnson.** (Chem. Soc., Journ. 87. pp. 1597–1600, Oct., 1905.) —Walden [see Abstract No. 217 (1904)], in his paper on abnormal electrolytes, first studied the electrical behaviour of solutions of acetamide, and the authors have made a further investigation of this, using inorganic salts as solute. The acetamide, purified by repeated crystallisation from benzene, had a specific conductivity at 100° of $4{\cdot}3 \times 10^{-5}$. The solutions studied were those of mercuric chloride, potassium iodide, potassium cyanide, and potassium chloride in acetamide. As in aqueous solutions, the molecular conductivity of potassium chloride is greater than that of mercuric chloride; also the three potassium salts possess about the same molecular conductivity in acetamide solution, at equivalent concentrations. With increasing dilution, the molecular conductivity of mercuric chloride increases normally, but that of the three salts of potassium appears to rise to a maximum and then to fall off rapidly. The authors have also compared the migration ratios of the $K^{\cdot}$ and I' ions in acetamide solution, and the result points to the assumption that the ions contained in the acetamide solution are different from those in aqueous solution.

A. F.

603. *Electrical Conductivity of Solutions in Liquid Iodine.* **G. N. Lewis** and **P. Wheeler.** (Amer. Acad., Proc. 41. No. 19. pp. 419–432, Jan., 1906. Contribution from the Chem. Lab. of Harvard College.)—Potassium iodide is readily soluble in liquid iodine, forming solutions which, when concentrated, conduct the electric current as well as the best aqueous solutions. Determinations of conductivity were made at 140° and 160° C. For solutions varying in concentration from 0·1 to 1·0 per cent. by weight the molecular conductivity increases linearly with the concentration. With greater concentrations the molecular conductivity does not increase proportionately to the concentration, but rises to a maximum in 5 per cent. solutions and then falls again. By assuming an interaction between the solvent and the solute, in the sense that the potassium iodide increases the dissociating power of the iodine, an explanation can be given of the fact that the degree of dissociation increases with the concentration. This will also explain the deviations of strong electrolytes from Ostwald's dilution law in aqueous solutions. The temperature coefficient of conductivity is negative for dilute solutions, but

with increasing concentration passes through zero and becomes positive. The authors have not been able to decide whether pure iodine possesses a conductivity of its own. T. S. P.

604. *Rate of Oxidation in Gaseous Oxygen.* **W. P. Jorissen** and **W. E. Ringer.** (Chem. News, 92. pp. 150–152, Sept. 29, 1905.)—Previous investigations of the so-called "boundary-pressure," at which the visible oxidation of phosphorus in oxygen begins, give widely varying results, probably owing to neglect of the moisture present and of the purity. Avoiding these sources of error, the authors find that, at 15° C. and with oxygen saturated with water vapour at this temperature, oxidation takes place if the pressure of the oxygen is not greater than 600 mm.; the presence of potassium iodide solution, which absorbs any ozone formed, does not diminish this pressure. Drying the oxygen with calcium chloride, sulphuric acid, or phosphoric anhydride lowers the value. The emanations from 5 mgm. of radium bromide are without influence, but the electric arc seems to increase the velocity of oxidation. T. H. P.

605. *Absorption of CO_2 in Aqueous Salt Solutions and in Binary Liquid Mixtures.* **A. Christoff.** (Zeitschr. Phys. Chem. 53. pp. 321–340, Oct. 10, 1905. Communication from the Chem.-Laborat. d. Univ., in Sofia.)—The solubility of CO_2 in various salt solutions was investigated by the author. The results of the investigation were the following: (1) Solutions of acid salts absorb less CO_2 than pure water. (2) The alums absorb the same amount of CO_2 as the simple sulphates. (3) The solution of CO_2 in binary liquid mixtures is influenced by the absorbing power of the pure liquids for CO_2, and also by the change of surface tension. (4) Solutions of borates and of ortho- and pyrophosphates absorb less CO_2 than is required to form 1 mol. of bicarbonate from 1 mol. of the salt. F. J. B.

606. *Convection Effects in a Heated Tube.* **C. H. Burgess.** (Manchester Lit. and Phil. Soc., Mem. 50. 1. pp. 1–3, Dec. 31, 1905.)—Referring to Whetham's experiments (Phil. Trans. A. 184. p. 337, 1893) in connection with the behaviour of a blue solution of cobalt chloride in alcohol superimposed on a heavier red alcoholic solution of cobalt nitrate, when it was found that on passing a current through the solutions a number of purple lines were formed at the junction of the two solutions, the author communicates several experiments in which he seeks to show that the effect was not due to the presence of complex ions, but was simply a heating effect. For example, he placed in the bend of a U-tube hydrochloric acid coloured by a red dye, and above this hydrochloric acid. On standing overnight the junctions of the liquids had become diffuse, and on passing a current of ½ amp. through the liquid, step-like bands were formed in place of the diffusion band. The formation of the bands he attributes to the ascent of a hot column of liquid up the centre of the tube and the cutting off of the head of this column by the cold liquid flowing in from the sides of the tube. He concludes, therefore, that Whetham's experiments do not necessitate the assumption of complex ions. [In this connection reference should be made especially to the work of Donnan and Bassett, Abstract No. 270 (1903), in which the presence of complex ions in solutions of cobalt salts under particular conditions is demonstrated with practical certainty. It is not the formation of bands, as in Whetham's experiments, but the movement of the coloured solution towards one or other electrode that indicates the presence of coloured ions.] A. F.

607. *Osmotic Pressure of Dilute Aqueous Solutions.* **P. S. Barlow.** (Cambridge Phil. Soc., Proc. 13. pp. 229–240, Jan. 31, 1906.)—The author communicates the results of a number of experiments on the osmotic pressure of dilute solutions, carried out directly with semi-permeable membranes supported in porous pots. He first shows that it requires a considerable time (amounting to several weeks) to wash a cell free from all traces of soluble substance previously used in the cell. Further, his experiments show that in the direct method of measuring osmotic pressures the values obtained are too low, owing to the outer water becoming contaminated by impurities from the air, and, even when these are excluded, from the clay of the pot.

A. F.

608. *Reversible and Irreversible Transformations of Nickel Steel.* **L. Dumas.** (Iron and Steel Inst., Journ. 68. pp. 255–289; Discussion and Correspondence, pp. 290–300, 1905.)—Deals exhaustively with the transformations (reversible and irreversible) undergone by nickel steels. The former are of comparatively small metallurgical importance; in the steels of the series lower in nickel content these reversible transformations are masked by the irreversible ones, but by the action of carbon and Mn the author causes a lowering of the transition-temperature of the irreversible transformations, and thereby shows the occurrence of reversible transformations in such steels. The irreversible transformations are of great importance, being accompanied by changes of physical properties, the most striking of which is the appearance of magnetism, and a considerable hardening of the metal. This hardening the author considers to be of the same kind as that produced in ordinary steel by working or mechanical deformation. Evidence in favour of this view is drawn from the fact that a steel mechanically hardened by deformation is found not to be much further changed when caused to pass through the irreversible transformation by cooling to a low temperature. The author summarises the work of Osmond and Guillet on these steels, and describes a large series of tests carried out by himself, for the details of which the reader must be referred to the original paper. The general conclusions are summed up as follows: Ni, Mn, and carbon, introduced into steel, alike produce irreversible transformations, the phenomena being more intense the higher the proportions of these elements present—but they must be present in solution. In the case of carbon this is often impossible except by the aid of Cr; the Cr itself, however, does not give rise to irreversible transformations. Nickel steels present the most perfect examples known of solid solutions, no segregation having ever been detected microscopically. Just as saline solutions are subject to internal stresses (osmotic pressure), so the author considers the addition of nickel causes internal stresses in these steels, increasing in intensity with the amount of nickel added; this reveals itself by an internal "working" accompanying the irreversible transformations. Applying Osmond's allotropic theory of iron to these phenomena, the author concludes that the properties of nickel steel are those of iron modified and even exaggerated by the influence of the elements held in solution, the property of undergoing allotropic modification being, in particular, most distinctly recognisable.

W. Ros.

609. *Use of Vanadium in Metallurgy.* **L. Guillet.** (Iron and Steel Inst., Journ. 68. pp. 118–165, 1905. Engineering, 80. pp. 601 and 603–606, Nov. 3; and pp. 638–640, Nov. 10, 1905.)—The methods of extraction and properties of vanadium are recapitulated, and the results of the author's experiments on vanadium

steels described [see Abstract No. 2222B (1904)]. Results with quaternary steels are given. The effects of Ni and V together are roughly equivalent to the separate effects superposed, and the addition of V to Ni steels is of practical interest only in the case of pearlitic steels ; it destroys some of the more interesting properties of the polyhedric (γ-iron) steels. Quenching pearlitic Ni-V steels produces a great increase of tensile strength, whilst elongation and toughness under shock still remain considerable—this in a more marked degree than with elements other than V. The effects of V upon Mn steels correspond closely to those upon Ni steels [see Abstracts Nos. 1276B and 1988B (1904)]. Vanadium has a favourable influence upon the mechanical properties of Si steels, but does not rid them of their brittleness at right-angles to the direction of rolling. Vanadium and carbon act with greater intensity than other elements in improving iron alloys. Alloys of V, Fe, and C, however, are more sensitive to heat treatment and mechanical handling than carbon steels, but the quaternary V steels (particularly Ni-V) do not appear to be so. Low percentages of V dissolve in Cu, but above 7 per cent. an insoluble substance separates out. This portion is unsuitable for use in preparation of V bronzes. The present high price of ferro-vanadium (about £1 per lb. of V contained) is attributed to the yet scanty demand. F. R.

610. *Phosphides and Carbides in Iron.* **J. E. Stead.** (Iron and Steel Mag. 10. pp. 552–558, Dec., 1905. From the Iron and Coal Trades Review, Nov. 3, 1905.)—The author found that in a series of 0·8 per cent. carbon steels phosphorus tended to segregate at, and carbon to avoid, the junctions of the primary crystals. With increasing phosphorus tensile tests showed about 2·5 tons per sq. in. increase of yield and breaking stress per 0·1 per cent. phosphorus. Arnold tests [see Abstract No. 2795B (1904)] showed increasing brittleness, and Wöhler cantilever tests showed increasing endurance of fatigue. With larger ingots than the 6-in. cubes used excessive segregation would have caused the results to be different. It is suggested that if ingots were revolved during cooling, segregation would be so diminished that ghost lines would probably not appear in the forging. F. R.

611. *Nickel-Vanadium Steels.* **L. Guillet.** (Soc. d'Encouragement, 107. Rev. de Métallurgie, pp. 870–881, Dec. 31, 1905.)—The author's investigations were performed on two series of pearlitic, martensitic, and polyhedric nickel steels, containing respectively about 0·2 and 0·8 per cent. of carbon, and to which from 0·2 to 7·0 per cent. V had been added. The general influence of V is to slightly lower the positions of the boundary lines between types [see Abstracts Nos. 1787B (1904) and 1670 (1905)]. Up to 0·7 to 1·0 per cent. V increases the strength of pearlitic Ni steels considerably, reducing elongation and contraction slightly ; it makes γ-iron steels brittle. The strength of the former when quenched is extraordinarily increased, and they are not embrittled ; the latter are slightly softened by quenching. [See also Abstracts Nos. 609 and 152B (1906).] F. R.

612. *Influence of Phosphorus on the Solubility of Carbon in Iron.* **F. Fettweis.** (Metallurgie, 3. pp. 60–62, Jan. 22, 1906. Communication from the eisenhüttenmänn. Inst. d. kgl. techn. Hochschule, Aachen.)—Describes a repetition of Stead's experiments, but with special precautions to ensure the saturation of the iron with carbon and re-determinations of the phosphorus in each alloy produced. The results lead the author to conclude that Stead's

alloys were not completely saturated with carbon, and that iron phosphide is itself capable of dissolving a small amount of carbon. The latter conclusion is based on the observation that alloys containing 15·8 per cent. P, corresponding to the compound Fe_3P, could never be obtained free from carbon, while the carbon contents of other iron-phosphorus alloys are also most rationally explained on the view indicated. W. Ros.

613. *Mechanical Properties of Sheet Zinc.* **O. Meyer.** (Metallurgie, 3. pp. 58–59, Jan. 22, 1906.)—Describes tensile and bending tests made on specimens of sheet zinc as delivered by the makers and after etching in nitric acid and exposure to a temperature of 275° C. for 1 hour. The effects of slight additions of Cd and Pb, both separately and together, are also investigated. The tensile tests show that Hooke's law is not strictly obeyed and that values of Young's modulus can only be given as an average over a certain range of loading; elastic limit and yield-point are ill-defined. Both in the state as delivered and after transformation by heating, the sheet zinc shows a greater tenacity, but reduced ductility, in a direction transverse to that of rolling than in the latter direction. Heating as described affects all the mechanical properties unfavourably and changes the appearance of the fracture from fine silky to coarsely crystalline. An addition of 0·2 per cent. Cd distinctly improves the mechanical properties, but additions of more than 0·4 per cent. Cd have either no perceptible effect or a deleterious one; the presence of Pb is always injurious, and the effects are still more pronounced when Pb and Cd are both present. W. Ros.

614. *Lead-Arsenic Alloys.* **K. Friedrich.** (Metallurgie, 3. pp. 41–52 Jan. 22, 1906. Communication from the Metallog. Laborat. der k. Bergakad. Freiberg.)—The determination of the temperature-concentration diagram for alloys containing up to 34·4 per cent. As is described. Since these alloys undergo segregation while still fluid, it is impossible to find the exact shape of the freezing-point curve; the results are sufficient to show, however, that the true diagram consists of a eutectic horizontal upon which two other branches intersect. The eutectic horizontal lies at 292° C., but it is not certain whether the line is continuous or not, *i.e.*, whether any mixed crystals are formed. Of the two branches of the freezing-point curve, the shorter one commences at the freezing-point of pure Pb and cuts the eutectic line at a concentration of 2·5 to 3 per cent. As. On the other branch of the curve, rising from the eutectic point with increased concentration of As, no maximum or tendency towards horizontality can be detected, and as no other eutectic arrest-points can be discovered the author concludes that the compounds of Pb and As described by earlier authors, cannot be formed in these alloys. The results of the author's investigation do not enable him to determine the composition of the compound whose crystallisation corresponds to the longer branch of the freezing-point curve. The author's results are in good agreement with those of Heycock and Neville. The paper is illustrated with nine photo-micrographs of sections of the ingots of these alloys, which confirm the results derived from theoretical considerations. The author also points out the impossibility of obtaining fair average samples of these alloys for analysis, and also deals with the bearing of his results upon the separation of As from Pb by segregation methods. W. Ros.

615. *Effects of Elements on Structure of Cast Iron.* **A. H. Hiorns.** (Soc. Chem. Ind., Journ. 25. pp. 50–53; Discussion, pp. 53–54, Jan. 31, 1906. Paper

read before the Birmingham Section.)—Samples were prepared by melting a pure high-carbon steel with carbon, and adding the element whose effect was to be studied. The conclusions confirm those of others, that the system stable below 1,030° C. is iron + graphite. The view of Tieman and Howe that Si causes the separation of graphite by catalysis, is not favoured. The opposite action of Mn is possibly due to the formation of double carbide of Fe and Mn in absence of S and Si. If the latter be present, Mn may unite with it, and so prevent its usual action. A series of samples with increasing phosphorus, and a sample with 1 per cent. S, are also described. In the latter, sulphide of iron could be observed, and no graphite. *Discussion.*—**T. Turner** said that he found a relation between the "number" of an iron and the size of its graphite flakes. Flakes were larger the higher the temperature at which they separated. He considered that under ordinary circumstances the presence of some Si is essential to the separation of graphite. **Buchanan** believed that Si was only effective in separating graphite at temperatures slightly short of the melting-point, and upwards, but not at annealing temperatures. **O. F. Hudson** said that slow cooling through 1,130° C., the eutectic temperature, was the condition most favourable to the separation of graphite, although further separation could go on with continued slow cooling. F. R.

616. *Complex Formation, Hydration and Colour.* **F. G. Donnan.** (Zeitschr. Phys. Chem. 53. pp. 317–320, Oct. 10, 1905. Muspratt Lab. of Physical and Electro-Chemistry, Liverpool Univ., June 28, 1905.)—G. N. Lewis has assumed that the changes of colour which occur in solutions of cobalt and copper chlorides are due entirely to hydration and dehydration. Attention is called to several researches [Donnan and Bassett, Abstract No. 270 (1903); Kohlschütter, Ber. Deut. Chem. Gesell. 37. p. 1158 (1904).] which show that the changes are probably due to the formation of complex anions and kathions. In the case of copper it is suggested that water and chlorine are capable of displacing one another in the complexes and that perhaps 5 compounds may exist, *e.g.*:—

$$\overset{++}{\mathrm{Cu}}\,.\,4\mathrm{H_2O}\ \big|\ \overset{+}{\mathrm{Cu}}\mathrm{Cl}\,.\,3\mathrm{H_2O}\ \Big|\ \mathrm{CuCl_2}\,.\,2\mathrm{H_2O}\ \Big|\ \overset{-}{\mathrm{Cu}}\mathrm{Cl_3}\,.\,\mathrm{H_2O}\ \big|\ \overset{-}{\mathrm{Cu}}\overset{-}{\mathrm{Cl}}_4$$

complex kathions | hydrated salt | complex anions

the colour changing from blue, through green and yellow to brown as the negative charge accumulates. Similar complexes are formed when alkaline chlorides are added to the copper or cobalt chloride, and the colour of the double salts appears to be determined by the nature of the copper complexes contained in them. T. M. L.

617. *Copper and Sulphur.* **E. Heyn** and **O. Bauer.** (Metallurgie, 3. pp. 73–86, Feb. 8, 1906. Communication from the Metallog. Laborat. d. Kgl. Materialprüfungsamtes Gross-Lichterfelde, Berlin.)—Describes investigations of the freezing-points and microstructure of the copper-sulphur alloys, with the following results: (1) Cu and Cu_2S are not mutually soluble in all proportions in the fluid state, so that the molten alloys at certain concentrations form two layers, the lower layer being richer in Cu. (2) In the solid state, no mixed crystals of Cu and Cu_2S are formed. A eutectic is formed containing 3·82 per cent. Cu_2S; alloys containing less than this amount of sulphide consist of Cu crystals surrounded by eutectic, while alloys richer in

sulphide consist of crystals of sulphide embedded in the eutectic. Alloys containing more than 9 per cent. of sulphide separate into two layers. (3) Very minute quantities of sulphide in copper can be detected microscopically. The inclusions of sulphide resemble those of oxide (Cu_2O) but can be distinguished from them by etching with hydrofluoric acid, which attacks and darkens oxide enclosures but does not change sulphide enclosures. (4) The observed depressions of the freezing-points in dilute solutions agree with the formula of Raoult and van't Hoff. (5) Sulphurous acid does not attack copper at temperatures between 900° and 1,100° C. except in the presence of a reducing agent such as carbon or hydrogen, copper being in this respect unlike iron. In the presence of a reducing agent, Cu_2S is formed. (6) Cu_2O and Cu_2S cannot coexist at the melting-point of the sulphide; the bodies react with the formation of copper and sulphurous acid, until the supply of one of the bodies is exhausted. (7) Se and Te behave in respect of Cu in the same way as sulphur, and the corresponding compounds cannot be distinguished from the sulphide by their appearance; but by the action of potassium cyanide solution, alcohol and cadmium acetate the presence of sulphur, Se and Te in Cu filings can be readily proved, even when Se and Te are both present. The paper is illustrated by 18 photomicrographs which support the conclusions of the author. W. Ros.

618. *Do Crystals Soften in the Neighbourhood of their Melting-point?* **N. Slatowratsky** and **G. Tammann.** (Zeitschr. Phys. Chem. 53. pp. 341–348, Oct. 10, 1905. Inst. f. anorg. Chem., Göttingen.)—Experiments were made on the rate of flow of crystalline naphthalene and yellow phosphorus when compressed in a narrow cylinder by means of a piston of smaller diam. which allowed the solid to escape round the margin. It was found that the plasticity increased greatly in the neighbourhood of the melting-point, but most of this effect was traced to the presence of impurities, which lowered the melting-point of the crystals, at least locally. It was found that the impurity could largely be removed from the naphthalene by compressing the crystals and squeezing out the more plastic material. When working with purified material it was found that the plasticity was doubled every 10° C. up to 75°, when a more rapid increase occurred; the impure material showed a much greater increase of plasticity, commencing at a lower temperature; the melting-point under normal pressure was 70° C. It is probable that in pure material there would be no specially marked increase of plasticity and no special softening near the melting-point. T. M. L.

619. *Action of Nitrogen on Water Vapour at High Temperatures.* **O. F. Tower.** (Amer. Chem. Soc., Journ. 27. pp. 1209–1216, Oct., 1905.)—The reaction $N_2 + 2H_2O = 2NO + H_2$, takes place extremely slowly when the mixed gases are either subjected to the action of sparks from a large induction coil or heated to 2,000° in an electrically-heated Nernst iridium furnace. An equilibrium is reached when about 4 c.cm. of nitric oxide are present per litre, the amount calculated from the dissociation of water vapour and the equilibrium between nitrogen, oxygen, and nitric oxide being 3·3 c.cm. T. H. P.

620. *Supposed Anomaly in Osmotic Pressure of a Bicarbonate Mineral Water.* **L. Graux.** (Comptes Rendus, 142. pp. 166–167, Jan. 15, 1906.)—From experimental results the conclusion is drawn that a solution of bicarbonate

of soda contains only the normal carbonate and carbonic acid; the former exerts an osmotic pressure, whereas the latter does not. **L. C. Maillard** and **L. Graux.** (Ibid. pp. 404–407, Feb. 12.)—The authors have now investigated the matter more fully, and find that if the salts in solution are considered to be completely dissociated, the carbonates to be present as bicarbonates and dissociated into two ions, and the CO_2 and silica to exist in the molecular state, the agreement between the observed and calculated lowerings of the freezing-point is satisfactory. The assumptions made in the previous paper are therefore not valid, and rested on insufficient evidence. T. S. P.

621. *Disintegration of Iridium by Carbon Dioxide and Dissociation of the Gas.* **F. Emich.** (Monatsh. f. Chemie, 26. pp. 1011–1020, 1905.)—The author makes use of the loss in weight (disintegration) of strips of iridium electrically heated, in CO_2 and in nitrogen containing various amounts of oxygen, to temperatures measured by Holborn and Kurlbaum's optical pyrometer, for the purpose of determining the degree of dissociation of CO_2 at high temperatures. The results obtained up to the present are as follows:—

Temperature.	Percentage Dissociation of Carbon Dioxide.		
	Emich.	le Chatelier.	Trevor and Kortwright.
1,500° C.	About 0·1	0·8	1
1,970°	„ 4·5	4·0	8
2,150°	„ 10–11	9·0	14

T. H. P.

622. *Generator-gas and Carbon Elements.* **F. Haber** and **A. Moser.** (Zeitschr. Elektrochem. 11. pp. 593–609, Sept. 8, 1905. From the Chem.-tech. Inst. der techn. Hochschule, Karlsruhe.)—In a generator-gas element in which glass is used as the electrolyte the authors show that, at the boiling-points of sulphur and of P_2O_5, the e.m.f. corresponds well with that required by thermodynamical theory. The same is the case with the effects produced by changes in the concentration of CO, O, and CO_2. By using concentrated CO the generator-gas element is converted, as theory requires, into the carbon-element. The use of heated glass as an electrolyte also permits of the detonating-gas (Knallgas) element being realised at high temperatures. [See also Haber and Bruner, Abstract No. 892 (1905).] T. H. P.

623. *Union of Hydrogen and Oxygen at Low Pressures caused by the Heating of Platinum.* **P. J. Kirkby.** (Phil. Mag. 10. pp. 467–476, Oct., 1905.)—In the presence of hydrogen and oxygen at a low pressure platinum does not cause these gases to combine perceptibly unless its temperature exceeds a certain critical value, which is approximately independent of the pressure of the mixed gases, so long at least as this pressure lies between 40 mm. and 2 mm., and which is about 275° for pure Pt. The same property may belong to impure Pt. Heating of the Pt above this critical temperature causes an increase in the rate of combination of the gases. After heating the Pt sufficiently to start the reaction between the gases, this reaction may be temporarily renewed by raising the Pt to a temperature distinctly lower than that at first required. The reaction is probably connected with the corpuscular discharge known to be emitted by platinum. [See also Abstract No. 1268 (1905).] T. H. P.

624. *Oxidation of Nitrogen in the High-tension Flame.* **J. Brode.** (Zeitschr. Elektrochem. 11. pp. 752–754, Oct. 27, 1905. Paper read before the 12 Hauptversamml. d. Deutsch. Bunsen-Gesell., Karlsruhe, June 1–4, 1905.)—The flame produced by a high-tension electric discharge in air comprises three zones. The current is unaltered by introducing a non-conducting body into the two upper zones, but with the lowest zone the current is affected, so that this part of the flame is the path of the discharge, and is also the hottest part of the flame. Since from Nernst's measurements, the equilibrium concentrations of the nitrogen and oxygen are known for any temperature, the temperature of the flame can be determined by analysing the gases drawn from it, and in the hottest part it is found to be 3,700° C. In the uppermost zone the nitric oxide formed in the lowest one undergoes decomposition. In the middle zone the ozone formed in the lowest zone is probably decomposed, because in hydrogen or nitrogen only a flame corresponding with the lowest zone of the air flame is produced, whilst in the oxygen flame the middle and lower zones are represented. The formation of ozone depends alone on the high temperature and not on the ultra-violet light. The results show that in the production of nitric oxide by electric discharges the formation of flame must be avoided, since the nitric oxide formed in the hotter parts of the flame is decomposed in the cooler parts. T. H. P.

625. *Influence of Silent Discharge on Ammonia and Oxygen.* **R. Pohl.** (Deutsch. Phys. Gesell., Verh. 8. 2. pp. 10–15, Jan. 30, 1906. Phys. Inst. d. Univ., Berlin, Jan., 1906.)—The "ozone tube" containing the gas was connected up in series with an adjustable resistance to a transformer, the frequency of the alternating current being 50. The current strength was measured by a Wolf resistance (up to 150,000 ohms, and free from self-induction) and a Dolezalek electrometer (reading from 8 to 25 volts). The p.d. between the terminals of the tube was measured by a Braun electrometer. Tables are given showing how the decomposition of ammonia depends on (i.) the pressure, (ii.) the potential, (iii.) the length of the electrodes and the current density, and (iv.) the thickness of the layer of gas between the electrodes. Two tables are given for oxygen, showing how the amount converted to ozone varies with the potential—(i.) with air in the tube, and (ii.) with 98½ per cent. of oxygen. A. W.

626. *Carbon Dioxide and the Point Discharge.* **T. Noda.** (Ann. d. Physik, 19. 1. pp. 1–13, Jan. 18, 1906.)—The quantitative measurements concerning the conversion of oxygen into ozone by means of the silent electric discharge may be extended to other gases, and the author has made some measurements of the electric quantity and current intensity required to decompose CO_2 into CO and O, while bearing in mind the fact that part of the O evolved is ozonised. He used a point discharge, and measured the decomposition by means of the pressure, using a differential ozonometer for evaluating the ozone. He found that the decomposition of CO_2 by the point discharge is much more efficient than it would be by electrolysis. For whereas in electrolysis 96,540 coulombs would be required for decomposing 1 gm.-equivalent of CO_2, the quantity required in the point discharge is only 2,610 coulombs, and yet the effective work is limited to the luminous space at the point, and amounts to about 10 per cent. of the total work, and of this tenth only 11 per cent. is converted into chemical energy. The author finds, as in Faraday's law, that the quantity of CO_2 decomposed only depends on the quantity of electricity passing, and not upon the current intensity. The efficiency of the decomposing process increases with the temperature and the pressure of the gas. E. E. F.

627. *Mean Potential at Electrodes under the Action of Alternating Currents.* **P. G. Gundry.** (Zeitschr. Phys. Chem. 53. pp. 177–212, Sept. 19, 1905.)—On passing an alternating current through an electrolyte between two mercury electrodes, one very small and the other so large as to be regarded as unpolarisable compared with the first, two different effects are observable: (1) Asymmetry of the polarisation, expressed by the asymmetry of the logarithmic function in the formula for the polarisation, $R \textcircled{H} \log (C/c)$. In correspondence with this effect a direct current flows in the electrolyte from the smaller to the larger electrode. (2) Asymmetric action of the alternating current, the kathodic component of the current being partially transported by hydrogen. In the case of typical salts the second effect masks the first, whilst with complex salts, especially such as have an alkaline reaction, the opposite occurs. T. H. P.

628. *Kathode Potentials required for Electrolytic Separation of Metals from their Sulphate Solutions.* **G. Coffetti** and **F. Foerster.** (Ber. Deut. Chem. Gesell. 38. pp. 2934–2944, 1905.)—Employing an electrolytic cell containing a N/1 solution of the sulphate with an anode of the pure metal and a kathode of platinum 0·5 mm. thick, the edges and surface of which were covered with shellac, the authors have determined the potential required to effect separation of various metals from solutions of their sulphates, the e.m.f. of the kathode being measured by an Ostwald's capillary electrometer at various current densities which were in each case maintained constant for some time. With cadmium, 10 per cent. of hydrofluosilicic acid was added to the electrolyte to prevent uneven deposition of the metal. The potential found necessary for Fe, Ni, and Co is intermediate between those required for Cd and Zn respectively. The high "back e.m.f." of hydrogen against the latter is considered to explain why iron is not deposited quantitatively from a weak acid solution. W. H. Si.

629. *Electrolytic Extraction of Calcium.* **S. A. Tucker** and **J. B. Whitney.** (Amer. Chem. Soc., Journ. 28. pp. 84–87, Jan., 1906.)—The method of Goodwin was used. [See Abstract No. 859 (1905).] The anode consisted of a graphite crucible turned from an Acheson graphite electrode with a cavity for the electrolyte 10 cm. diam. and 10 cm. deep. The bottom was water-cooled by a coil of copper tube, through which water was circulated. This coil was let into the bottom of the crucible, the latter being only about 8 mm. in thickness. A layer of fluorspar was placed on the bottom of the crucible. As kathode an iron rod 15 mm. in diam. was used, which was adjustable so that it could be raised and lowered by the use of a wheel and screw mechanism. Commercial fused $CaCl_2$ was melted by a blowpipe and then poured on the fluorspar and the kathode at once lowered. As the chloride fuses by the electric heating, calcium begins to collect round the iron rod and should be soon removed, otherwise it is rapidly oxidised. Between 125–150 amps. gives the best result. It is essential to keep the temperature of the bath about 720° C. To assist in this a water-cooled kathode was tried with success, which enabled a yield of 60 per cent. to be obtained. It is necessary to remove the calcium from the actual contact with the electrolyte as it is formed. This is done by raising the kathode gradually by the hand-wheel. When the rod of calcium thus formed becomes so long that the cooling effect of the water circulation inside the kathode is lost, the metal is removed and the process again resumed by bringing the cooled iron again in contact with the electrolyte. W. W. H. G.

630. *Galvanic Polarisation of a Mercury Kathode.* **G. N. Lewis** and **R. F. Jackson.** (Amer. Acad., Proc. 41. No. 18. pp. 399–415, Jan., 1906. Contribution from the Chem. Lab. of Harvard College.)—The authors have studied the polarisation observed when hydrogen is deposited electrolytically on a mercury kathode. The anode, which was shown to be unpolarisable, consisted of a spiral of platinised Pt-foil, half immersed in the electrolyte (normal H_2SO_4) and bubbled over with hydrogen. Great care was taken that all the materials used were pure. The method of preparation of the mercury was new, and consisted of heating mercuric oxide of high purity obtained in the wet way, and condensing the mercury set free. The polarisation curve up to 0·7 volt is regular and shows no break in continuity. The relation between the potential E and the current I for increasing e.m.f. is given very exactly by the equation $E = A \log I + B$, where A and B are constants; if the potential is then gradually decreased once more the observed currents are greater than with increasing e.m.f. The theoretical basis of the above equation is discussed, and it is shown that the polarisation cannot be due to the slowness of diffusion either of hydrogen ions to the electrode, or of the hydrogen away from the kathode, but must be due to some intermediate reaction. This intermediate reaction is assumed to be the union of two hydrogen atoms to form a molecule. The effect of temperature could not be accurately studied, but indications were obtained that at a given potential the current is smaller the higher the temperature. At potentials higher than 0·7 volt the results obtained were very variable and require further investigation. T. S. P.

631. *Anodic Attack of Iron by Vagabond Currents in the Earth, and the Passive State of Iron.* **F. Haber** and **F. Goldschmidt.** (Zeitschr. Elektrochem. 12. pp. 49–74, Jan. 26, 1906. From the Chem.-techn. Inst. der techn. Hochschule, Karlsruhe. Écl. Électr. 46. pp. 275–280, Feb. 17; 316–318, Feb. 24; 358–360, March 3, and pp. 398–400, March 10, 1906.)—This paper deals with the corrosion of water and gas pipes caused by vagabond currents from electric tramway installations. It is divided into the following sections: (1) Survey of the problems awaiting investigation, and of the results already obtained. (2) Anodic behaviour of iron in carbonate and bicarbonate solutions. An iron anode becomes active and goes into solution as bicarbonate of iron as soon as the limiting layer of the electrolyte near the anode is changed into a bicarbonate solution containing carbonic acid. Heat has a deterrent effect on this action because the CO_2 is driven off. In a carbonate solution the anode remains passive

under ordinary conditions unless the carbonate solution is very dilute, *e.g.*, 1/100 normal. It can, however, be made active by preventing the diffusion away of the layer of solution in immediate contact with it. (3) Behaviour of iron as anode in alkali solutions containing chlorides. The anode is passive in solutions of calcium hydroxide of any strength, and in solutions of caustic soda which are not weaker than 0·02 molecular. It loses its passive condition, however, as soon as any potassium chloride is added to the alkali, even in strongly alkaline solutions. (4) The cause of the passive state in alkaline solutions. Experimental evidence is given in favour of the passive state being due to a layer of an oxide of iron which is in a higher state of oxidation than ferrous oxide, and possesses the conducting power of a metal. This oxide layer is supposed to contain a number of pores, which, however, are continually being closed up by the formation of fresh oxide, and new pores formed. (5) Measurements in the earth by means of contact electrodes (Tastelektroden). Holes were dug in the earth so that portions of water and gas pipes were laid bare. The p.d.'s existing between these pipes and (*a*) various places in the hole, or (*b*) the rails of an electric tramway were measured at different times of the day and night, by means of the special electrode. The authors come to the conclusion, to which, however, they do not bind themselves, that a p.d. of 1 volt or less between the rails and the water pipes is practically harmless, and any corrosion of the pipe is not due to electrolytic effects which depend on vagabond currents. T. S. P.

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632. *Preparation of Metallic Calcium for Laboratory Purposes.* **P. Wöhler.** (Zeitschr. Elektrochem. 11. pp. 612–618, Sept. 8, 1905. Communication from the Inst. für Physikal. Chemie und Elektrochemie der techn. Hochschule, Karlsruhe.)—The author gives details for the preparation of calcium for laboratory purposes according to the method of Rathenau [see Abstract No. 465 (1905)]. T. H. P.

633. *Cobalt and Nickel.* **H. Copaux.** (Annal. Chim. Phys. 6. pp. 508–574, Dec., 1905.)—This is a detailed account of the researches mentioned in Abstract No. 860 (1905). The paper deals with the qualitative and quantitative analyses of the compounds of Co and Ni; the preparation of the pure metals and their fusion; the physical constants; and with several cobalt compounds, some of them new. The similarity of the two metals is very marked; thus the density determinations for Co varied between 8·65 and 8·83, and for Ni between 8·64 and 8·80. H. B.

634. *Copper Silicide.* **E. Vigouroux.** (Comptes Rendus, 142. pp. 87–89, Jan. 8, 1906.) **P. Lebeau.** (Ibid. pp. 154–157, Jan. 15, 1906.)—Both authors confirm their previous work, that the maximum amount of silicon entering into combination with copper when the latter is heated with excess of silicon is approximately 10 per cent., a hard and brittle crystalline compound being obtained having a density of 7·48 and corresponding to the formula $SiCu_4$. It possesses a silvery metallic lustre, which rapidly tarnishes, becoming first yellow and then brick-red. W. H. Si.

635. *Annealing Steel Castings.* **F. H. Sexton.** (Iron and Steel Mag. 11. pp. 53–54, Jan., 1906. From Mining Soc. of Nova Scotia, Trans. Abstract.)—The author's experiments on a cast steel containing 0·38 per cent. C and 0·65 per cent. Mn confirmed the improvement in properties which has been found by others to be brought about by heating to 1,000° C., and cooling in the air—viz., the production of high elastic and breaking strength, combined with good ductility. F. R.

636. *Photochemical Behaviour of Mercuric Oxalate in Presence of Fluorescent Substances.* **A. Jodlbauer** and **H. v. Tappeiner.** (Ber. Deut. Chem. Gesell. 38. pp. 2602–2609, 1905.)—The fluoresceins (sodium salts) have a sensitising influence on Eder's reaction in an atmosphere of hydrogen, and the reaction can be made extraordinarily sensitive in presence of eosin. Of a number of non-fluorescing compounds examined by the authors, none exerts any accelerating influence.
L. H. W.

637. *Industrial Future of Special Steels.* **L. Guillet.** (Iron and Steel Mag. 11. pp. 89–95, Feb., 1906.)—The ternary and quaternary steels are classified by structure, and the applications of each class described. The pearlitic steels are undoubtedly of greatest importance. [See also Abstracts Nos. 1670 (1905) and 152B (1906).]
F. R.

638. *Hidden Equilibria in p.x. Sections under the Eutectic Point.* **A. Smits.** (Konink. Akad. Wetensch. Amsterdam, Versl. 14. pp. 564–568, Jan. 10, 1906. Proc. 8. pp. 568–571, Jan. 25, 1906. Zeitschr. Phys. Chem. 54. pp. 498–509, Jan. 30, 1906.)—A general consideration of the various regions and of the path of the solubility isotherm in them, with figures.
H. H. F. H.

639. *Use of the Differential Equation in Calculating Results of Kinetic Investigations.* **W. C. Bray.** (Journ. Phys. Chem. 9. pp. 573–587, Oct., 1905.)—The author describes a method for using the primary differential equation, which is of value when the integration is impossible or leads to very cumbrous expressions. The method requires the determination of values of *dx/dt*, which can be fairly accurately done if large quantities of the reacting mixture be used, so that a sufficient bulk may be employed for successive analyses. The method is applied to calculating the velocity of the reaction, $3I' + 2H^{\cdot} + H_3AsO_4 \longrightarrow H_3AsO_3 + I_3' + H_2O$ near the equilibrium-point.
F. G. D.

640. *Report of the International Atomic Weight Commission*, 1906. (Zeitschr. Anorg. Chem. 48. 2. pp. 129–136, Jan. 2, 1906. Amer. Chem. Soc., Journ. 28. pp. 1–7, Jan., 1906.)—An account is given of the atomic weight determinations made during the year 1905.
T. H. P.

641. *Relations between the Absorption Coefficient for Radiant Energy and Chemical Constitution.* **A. Byk.** (Phys. Zeitschr. 6. pp. 349–353, June 1, 1905. Paper read before the Chem. and Mining Sect. of the Berlin Techn. Hochschule.)—A *résumé*.

642. *Conductivity Measurements of Organic Acids.* **J. H. Süss.** (Akad. Wiss. Wien, Sitz. Ber. 114. 2b. pp. 867–878, July, 1905. From the I Chem. Laborat. der k.k. Univ., Wien.) — Forms an appendix to Wegscheider's measurements (Monatsh. f. Chemie, 23. p. 217, 1902).

643. *Molecular Conductivity of the Phosphoric Esters.* **P. Carré.** (Comptes Rendus, 141. pp. 764–766, Nov. 13, 1905.)—The results are tabulated. The ionisation of the esters is decidedly greater than that of phosphoric acid itself.
D. H. J.

644. *Molecular Volume of Dissolved Naphthalene.* **C. Forch.** (Ann. d. Physik, 17. 5. pp. 1012–1017, Sept. 26, 1905. Techn. Hochschule, Darmstadt.)—In chloroform, toluene, and carbon disulphide, dissolved naphthalene exhibits volume relations such as it would show if it were melted at a low temperature. With reference to the solute and solvent, the volumes are additive and independent of the concentration. Ethereal solutions exhibit relations different from these. [See also Abstracts Nos. 1973 and 3057 (1904).]
T. H. P.

645. *Equilibrium Form of Solid and Liquid Crystals.* **O. Lehmann.** (Ann. d. Physik, 17. 4. pp. 728–734, Aug. 22, 1905.)—This paper deals with the solubility, &c., of crystals at different points of their surfaces, especially when in an artificially deformed state. According to the author's view, the property which distinguishes a crystal from an amorphous body is the existence in it of a saturation-point with regard to solubility, melting, evaporation, &c., which is the same at all parts of the surface. T. H. P.

646. *The Carborundum Furnace.* **F. A. J. FitzGerald.** (Electrochem. Ind., N.Y. 4. pp. 53–55, Feb., 1906.)—A theoretical consideration of a type of horizontal resistance furnace with a core of granular coke is given, but it is concluded that in the present state of our knowledge it is not possible to make even approximate estimates of absolute efficiency. Two practical results are quoted: (1) Acheson found that 9 B.O.T. units produced 1 lb. of carborundum, and (2) Richards states that the Carborundum Co. in 1902 produced 7,000 lbs. of carborundum with an expenditure of 36,000 h.p.-hours, or 3·8 B.O.T. units per lb. W. W. H. G.

647. *Electrochemical Equivalent of Iodine.* **G. Gallo.** (Accad. Lincei, Atti, 15. pp. 24–35, Jan. 7, 1906.)—The International Commission on atomic weights (1897) adopted the value 126·86 for iodine. During the last three years further determinations have been made by Ladenburg (126·96 and 126·86), Scott (126·97), and Baxter (126·98). The present author has made a new departure by using an electrolytic method in which silver and iodine are deposited in the same circuit and accurately determined. The mean result from 24 determinations is 126·89 (O = 16). D. H. J.

648. *Electrolytic Reduction of Aromatic Acids to the corresponding Alcohols.* **C. Mettler.** (Ber. Deut. Chem. Gesell. 38. pp. 1745–1753, 1905.)—Solutions of benzoic acid, *m*-bromobenzoic acid, *o*-, *m*-, and *p*-chlorobenzoic acid, or other substituted benzoic acid, in a mixture of sulphuric acid and alcohol, are readily reduced to the corresponding alcohols by electrolysis at 20–30° in a divided cell using lead electrodes and a current strength of 10 amps. The yield varies from 70 to 90 per cent. [See also Abstract No. 895 (1905).] W. H. St.

649. *Electric Force in a Liquid wherein Diffusion is Occurring.* **S. Sano.** (Physico-Mathematical Soc., Tokyo, Proc. 2. 29. pp. 465–474, 1906.)—Nernst's method of calculating the difference of potential between two points in a dilute solution containing a single electrolyte in the state of complete dissociation is here extended to solutions not dilute. The results obtained are very complicated, but they reduce to Bancroft's for dilute solutions. The author thinks that the e.m.f. of a concentration cell cannot satisfactorily be calculated on the hypothesis that the cell is a reversible system. R. E. B.

650. *Transport of Liquids by the Electric Current.* **E. van der Ven.** (Archiv. Musée Teyler, 9. 1. pp. 97–130 and 9. 2. pp. 217–253, 1904.)—With solutions of potassium dichromate, potassium chromate, ferrous sulphate, and ferric chloride, the intensity of transport is: (1) directly proportional to the intensity of the transporting current, and (2) reciprocally proportional to the weight of salt contained in unit volume of the solution. In the case of ferrous sulphate, the transportation takes place from the anode to the kathode, and, with ferric chloride, in the opposite direction. [See Abstract No. 2364 (1904).] T. H. P.

651. *Polarisation in Voltameter.* **R. Thöldte.** (Ann. d. Physik, 18. 5. pp. 1061–1069, Dec. 28, 1905.)—Passing various currents and having the platinum electrodes at various distances in the dilute sulphuric acid—the author finds in all cases a maximum polarisation, and he concludes from this that no combination of the oppositely-charged ions occurs in the solution. P. E. S.